THE OHIO JOURNAL OF SCIENCE

VOLUME XXXVIII - 1938

LAURENCE H. SNYDER, Editor-in-Chief

PUBLISHED AT COLUMBUS, OHIO, BY THE

OHIO STATE UNIVERSITY

and the

OHIO ACADEMY OF SCIENCE

THE OHIO JOURNAL OF SCIENCE

THE OHIO JOURNAL OF SCIENCE

Is published jointly by the Ohio State University and the Ohio Academy of Science.

TABLE OF CONTENTS

VOLUME XXXVIII

NUMBER 1—JANUARY

NUMBER 2 -MARCH

NUMBER 3 MAY

NUMBER 4—JULY

NUMBER 5--SEPTEMBER

NUMBER 6 - NOVEMBER

THE OHIO JOURNAL OF SCIENCE

VOL. XXXVIII JANUARY, 1938 No. 1

CERTIFICATES OF GROWING UP AND GROWING OLD*

T. WINGATE TODD,

Anatomical Laboratory, Western Reserve University, and Associated Foundations

Growing is a subject for comment and congratulation. No child but revels in growth so vigorous that clothes have missed their chance of wearing out. Even if growth is measured in terms of weight, it is dimension not tonnage which gives pride and satisfaction. So dear to our hearts are the thoughts of our childhood that this one never fades and growth remains increase in dimension in all our natural ambition. With some misgivings and a trace of regret we force ourselves to think of growing up and hotly resent the thought of growing old. Both seem to be symbols of fading or of loss, Time's stealthy step like some far minute bell tolling us to our doom. Experience does not mean decline nor age senility. Organs are geared to last our time: their functional reserve or regenerative power preserves their integrity throughout life. Acute injuries followed by processes of repair, MacNider has shown, cause fixed cells to change their configuration, to modify their receptivity to injurious agents (7). Thus tissue resistance is acquired. The process of growing old enhances adaptability. Infirmity is the outcome of another process, the weakening of the resistance of these same cells, with senility as its end result if intercurrent afflictions have not destroyed the metabolic power. The organs are the armies, the adventurers, but the somatic tissues are the terrain which bears the scars of battle and the evidence of progress. Some somatic tissues, like the skin and hair and nails, can undergo great changes apparently with little consequent effect on the organism itself. Perhaps the central nervous system falls into this category. The ectoderm may even be misleading. Ento-

*An address presented to the Ohio Academy of Science, May 14, 1937.

dermic integrity is far more vital. But in the mesodermic structures bone and muscle, circulatory and respiratory systems, is betrayed the progress of the aging process which the organs themselves conceal. Of these the skeleton is most readily investigated, thanks to roentgenography. And that is why I ask your attention in a study of the bones, not as zoologists or anatomists, but as biologists intent upon the fundamental principles of life and their expression.

It is in an investigation such as this that one realizes most clearly the futility of sideral time to express in any way the progress of aging. The waxing phase of aging lasts we say some twenty years, a short portion of our whole life span but one during which aging progresses with tremendous speed. The waning phase is said to last from thirty-five years till the close of life, a period long in time but marked by relatively little change, so slowly does the aging process affect the healthy body. Twice previously have efforts been made to measure progress in aging, neither however very simple in execution. Lecomte de Noüy measured the rate of healing in a wound at different ages and found that it follows an exponential curve (6). The tissues of the body and the blood plasma together complete a closed system, changes in the one being reflected in the other. Consequently it has been suggested that the characters of the blood plasma may be used to demonstrate the progress of aging, through its power of retarding the vigor of cellular subdivision in vitro. Young plasma has very little more effect than a nutritive saline solution. Aged plasma will completely inhibit the subdivision (1).

The method which I propose has the advantage of calling for very simple technique, of affording a simple assessment, and of being equally reliable with the other two methods to which allusion has just been made. It also is applicable to all mammals as well as Man and readily enables comparisons of aging to be made in very different forms of mammal. It has the further advantage of registering health as well as maturity. The technique required is the roentgeneography of the limbs to show the stage of development of epiphysial centers if the animal be young; the condition of articular ends and degree of mineralization of the bones if the animal be adult. In human beings and large animals we make roentgenograms of left side only, hand, foot, elbow, knee, shoulder and hip. At certain stages roentgenograms of the vertebral column and perhaps of the sternal

ends of the clavicles are essential. But the vertebral column roentgenogram is no longer helpful after the twentieth birthday for then epiphyses of centra are united (21). And the roentgenogram of the clavicle is useless for a similar reason after the age of twenty-eight (12). Symphysis pubis can, however, be helpful up to thirty-five years (13). If the animal is small it is simplest to make one roentgenographic film of the entire body.

The method merely accomplishes by a quickly and easily applied technique what otherwise can be readily carried out by actual examination of the skeleton (11, 19, 20). It is applicable equally to the living and the dead. It gives us a picture of life in the fourth dimension, namely duration.

One need scarcely remind a biological audience that there are, in the skeleton, primary and secondary centers of ossification, that these appear at certain stages of early life, enlarge, take on the adult contour of the bone and finally merge themselves as integral parts of the skeleton. I purposely speak of primary as well as secondary centers for I do not want to confine our attention to epiphyses but include such skeletal elements as carpals and tarsals, union of primary innominate elements and even sutures.

The initial appearance of these centers and the ultimate incorporation of the bony element into which they develop in the skeleton, or fusion with the shaft if they appear in epiphyses, has been very crudely and unsatisfactorily investigated, usually without any collateral inquiry into the health or living conditions of the children studied. Consequently statistical reductions of age relationships have labelled both ossification and union unreliable as age indicators because of the considerable age range covered by each of these stages. That there is a considerable range in age is perfectly true. The important point is that if unions are systematically studied, it is found that the sequence of union is invariable. This fact I pointed out to Stevenson in 1923 on the basis of researches already carried out while making the collections of human and mammalian skeletons for the Hamann Museum. It was utilized by Stevenson as the theme for his thesis (11). The invariable sequence, despite the range in age relationship of union in each item, throws a very different light on the problem. It means that the entire union pattern is speeded up or retarded in relation to sidereal time. The question naturally arises: Why the individual

variation? Plotting our results on a very large series of observations (18), we find the curve skewed. It has an abrupt forward boundary and a straggling tail. Hence, there is a very definite limit to acceleration but no practical limit at all to retardation. Clearly this is not a feature inherent in the organism but something induced by the environment. Further investigation shows that retardation may be experimentally induced (17) or result from adverse conditions of health, diet or housing (16). As the result of infliction on successive generations the retardation may develop the aspect at least of a hereditary character (2).

Another closely related question occurs to one at this stage, namely, how, if the entire union sequence can swing forward or backward in sidereal time, one can tell without the evidence of the years whether the sequence is retarded or not. When retardation has reached a clinically significant degree, there are definite evidences, pathological or quasi-pathological in nature, which testify to its irregularity (3, 17, 20).

Still another question arises, born this time of the conventional linkage of ossification with union of epiphyses in thought and discussion. The epiphyses which ossify first unite last, it is said. In a sense this is true, but it is one of the half-truths which prove most misleading. Both primary and secondary centers appear in sheaves from which one or more centers may be missing owing to defects in available mineral, Vitamin D or both (4, 23). If a center fails to ossify on time, it may be delayed for a long while and other centers ossify ahead of it. But that has no influence on the age of final union. These two morphological processes, being influenced quite separately by environmental conditions occurring at great intervals of time, could not, except by accident, present a unified relationship to a third phenomenon.

It is extraordinary also that investigators of epiphysial ossification or union rarely thought of studying the bony nodule in the interior (9) until I brought this forcibly to scientific notice (14, 15, 18). At first mineral is laid down as a finely granular dot in the nubbin of cartilage. The granular dot is approximately spherical. Then it begins to grow lopsided and next fashions for itself a contour, extending irregularly until it begins to resemble the periphery of the adult bone or bone-end. The later stages, if it be a separate bone such as a carpal or a tarsal, progress slowly but individuality and vigor of outline is the result with all the characteristic modelling of the finished

bone. If the ossification is that of an epiphysis, there are stages in the face abutting on the shaft, just as characteristic as those of the subarticular contour, but they are not so suited for assessment into a chronological sequence.

The orderly sequence of development in the epiphysial, carpal or tarsal contour can readily be recorded as we have done for the human skeleton (15) and are now describing in more complete detail (18). Thus initial ossification, sequence in fashioning of contour and ultimate union can all be used as indicators of progressive maturation in the skeleton.

But there are pitfalls. The sick child or unhealthy animal will not be easy to assess. Retardation of progress may result in delayed union, though the sequence of union in the approximately fifty skeletal areas of epiphyses to be studied will usually be retarded as a program, not in some haphazard fashion. Under certain conditions, it is true, one or two epiphyses are picked out and retarded while the progress of union in the skeleton as a whole passes them by. Retardation which is often erratic, irregular and asymmetrical in the epiphysis, though not bilaterally asymmetrical, may occur in the phase of expanding bony contour. Deficiency in necessary mineral or catalyst may cause delay in the initial ossification of one or more in a sheaf of centers. All these are special problems for the investigator who is making a tool of the phenomenon of ossification. They have been discussed in considerable detail elsewhere and need not delay us now. It is these features, however, which have given rise to the assumption of natural variation through lack of understanding of the cause of individual difference.

The first use to which we put this special knowledge of the sequence in skeletal maturation was archeological. It was the identification of the age of Akhenaten, the heretic pharaoh of the Eighteenth Dynasty. Our assignment of twenty-two years to this active and restless personality has never been accepted but no one cavilled at the eighteen years assigned to one of his successors, Tutankhamen. We are now at work on the age of the famous Princes in the Tower, Edward V of England and his brother, the Duke of York. There is no doubt that the bones are the bones of these princes but they show evidence of such poor health in the children that both are retarded in progress between one and two years. The story of our disentangling the

mystery of a skeleton in a famous oil litigation has been already described in full (8).

Not only the anthropologist or the medico-legal expert finds an effective tool in skeletal maturation. The zoologist is enabled thereby to judge the comparative age of young skeletons and to assess in terms of maturation the evidence in any skeleton set before him. It is true in other mammals as in children that vagaries may be induced by dietetic deficiencies or health defects. But barring these, the assessment of maturation in any mammalian skeleton is not a difficult task. The assessment provides a ready means of investigating the duration of the several phases of growing up.

The physiologist's problem is this one of differential maturation. Our investigation of living primates, for the sequence can be studied by roentgenography in the living just as well as by dissection of the dead, shows that the phase of infancy and that of the grade school period in the anthropoid are very short whereas the preschool and adolescent phases cover about as much time as those phases of a child's life. It is in the slowing down of progress in different phases of maturation that the primate differs from the non-primate, the anthropoid from the Old World ape and Man from the anthropoid.

There is definite usefulness for this tool in the nutritionist's work. Not only is the sequence of maturation significant in keeping a check upon experimental animals but fluctuations in its progress may be assessed against a standard table or against controls in the investigation of optimum conditions of life and health or the influence upon the animal of specific experimental procedures.

Then there is a clinician's problem which has already been lightly sketched. Disturbances in the maturation program, retardations that is in progress, are signs of handicap far more pronounced than those which result merely in failure of growth. The recovery of a child from one of these more severe handicaps is announced in the restoration of normal progress in the maturation schedule.

There is a farmer's problem to be touched upon here. And this is not by any means the least significant for it is bound up in the larger issue of early and late maturing of stock and the raising of animals for meat. It has been touched upon but not systematically studied by Sanson (10), von Tscherwinsky

(22) and Hammond (5). We have given it considerable attention in our laboratory (17) and find it a fascinating study of very great practical community importance.

Of all the several aspects of the maturation pattern to which I would refer in this brief discussion, however, there is none that equals in its import that of the educator and the parent. Our school system is based on age and it is in terms of age that we evaluate the responsibilities of a child. That is our convention: it may lead us right or it may lead us wrong. The child himself chooses his companions by size without regard to age and this is a surer guide. But he realizes himself in terms of his maturity which is betrayed in his skeletal pattern for the organism, to be in health, must function as a unit. His aspirations, his hopes, his cravings, his human relationships are postulated not on age or experience or stature or weight but on the level he has reached in maturity, which we lightly call, "growing up." It is of little moment that a boy be twelve years old or have the stature of a lad of fourteen. If the level of his maturity be but ten years his thoughts and feelings will be determined by that level. Experiences beyond that will pass ineffectively over his head. If the girl be twelve years old and her stature that of ten, these will have no bearing at all on her capacity for social adjustment should her level in maturity be fifteen. To treat her as a child will be but to outrage her whole being and to evoke in her a resentment and the sullen rebellion in which unremitted misunderstanding inevitably results. When we shall have realized and based our domestic and social relationships upon this more complete knowledge, life will have greater fulness both for our children and for ourselves.

REFERENCES

(1) **Carrel, Alexis.** 1935. Man, the unknown. Harper, N. Y.
(2) **Dawson, A. B.** 1935. The influence of hereditary dwarfism on the differentiation of the skeleton of the mouse. Anat. Rec., vol. 61, pp. 485–493.
(3) ———. 1935. The sequence of epiphyseal union in the skeleton of the mouse with special reference to the phenomenon of "lapsed union." Anat. Rec., vol. 63, pp 93–99.
(4) **Francis, C. C., and P. P. Werle.** The appearance of centers of ossification from birth to five years (in preparation).
(5) **Hammond, John.** 1932. Growth and development of mutton qualities in the sheep. Oliver & Boyd, Lond.
(6) **Lecomte, du Noüy, P.** 1937. Biological time. Macmillan, N. Y.
(7) **MacNider, W. de B.** 1937. (Personal communication.) Concerning the significance of certain morphological changes developing in selected organs of aged animals. (In press.)
(8) **Mayer, Milton, and John Howe.** 1931. Steps in the dark. Rockwell, Chicago. pp. 197–202.

(9) **Pryor, J. W.** 1905. Development of the bones of the hand as shown by the X-ray method. Bull. State College Kentucky, ser. 2, no. 5.
———. 1906. Ossification of the epiphyses of the hand. Bull. State College Kentucky, ser. 3, no. 4.
———. 1908. The chronology and order of ossification of the bones of the human carpus. Bull. State Univ. Kentucky, new ser. 1, no. 2.
———. 1916. Some observations on the ossification of the bones of the hand. Bull. Univ. Kentucky, vol. 8, no. 11.
(10) **Sanson, A.** 1872. Mémoire sur la theorie du developpement précoce des animaux domestiques. J. de l'Anat. et de la Physiol., t. 8, pp. 113–159.
(11) **Stevenson, P. H.** 1924. Age order of epiphyseal union in Man. Am. J. Phys. Anthrop., vol. 7, pp. 53–93.
(12) **Todd, T. W., and J. D'Errico.** 1928. The clavicular epiphyses. Am. J. Anat., vol. 41, pp. 25–50.
(13) **Todd, T. W.** 1930. Age changes in the pubic bone. VIII. Roentgenographic differentiation. Am. J. Phys. Anthrop., vol. 14, pp. 255–271.
(14) ———. 1930. The roentgenographic appraisement of skeletal differentiation. Child Development, vol. 1, pp. 298–310.
(15) ———. 1932. Roentgenographic appraisement of developmental growth in the skeleton. White House Conference on Child Health and Protection, "Growth and Development of the Child. Pt. IV. Appraisement of the Child." Century, N. Y. pp. 258–279.
(16) ———. 1933. Growth and development of the skeleton. White House Conference on Child Health and Protection. "Growth and Development of the Child. Pt. II. Anatomy and Physiology." Century, N. Y. pp. 26–130.
(17) **Todd, T. W., Wharton, R. E., and Todd, A. W.** 1938. The effect of thyroid deficiency upon bodily growth and skeletal maturation in the sheep. Am. J. Anat. (In press.)
(18) **Todd, T. W.** 1937. Atlas of skeletal maturation. Pt. I. The hand. Mosby, St. Louis.
(19) **Todd, T. W., and A. W. Todd.** 1938. The epiphyseal union pattern of ungulates with a note on Sirenia. Am. J. Anat. (In press.)
(20) **Todd, T. W., Todd, A. W., and Todd, D. P.** Epiphyseal union in mammals with special reference to Rodentia. (In press.)
(21) **Todd, T. W., and R. B. Sommerfield.** The epiphyses of the vertebral column. (In preparation.)
(22) **von Tschirwinsky, N.** 1889. Zur Frage uber das Wachstum der Röhrenknochen und den muthmasslichen Zusammenhang dieses Wachstums mit dem Wechsel der Schneidzähne bei den Schafen. Landwirtschaftliche Jahrb., Bd. 18, S. 463–476.
(23) **Venar, Yasha, and T. W. Todd.** 1936. Experiments on the maintenance of mineral density in the skeleton. J. Lab. & Clin. Med., vol. 22, pp. 221–230.

Trail Blazers

This is a vivid story of the progress of science through five centuries told by a chronological series of a dozen biographies. The author writes with evident freedom of expression. His description of Calvin's part in the death of Servetus is a vivid picture but one which is not likely to be quoted by present day speakers on the harmonies of science and religion. Many of Gumpert's trail blazers are given more credit than that usually accorded to them in writings on the history of science. Servetus is pronounced the discoverer of the pulmonary circulation, Wolff appears as a pioneer for the doctrine of evolution, Meyer is credited with the original conception of the law of the conservation of energy, and Pettenkofer is pronounced the originator of the periodic system. Every chapter in this book is stimulating. The great volume of our American and English scientific literature serves as a barrier to the translation of many works from foreign languages. It is fortunate that this volume has passed that barrier.—*R. A. Hefner.*

Trail Blazers of Science, by Martin Gumpert. (Translated from the German by Edwin Shuman.) 300 pp. Funk and Wagnalls. $2.50.

THE TRANSFORMATION OF PERCENTAGES FOR USE IN THE ANALYSIS OF VARIANCE

C. I. BLISS,
Institute of Plant Protection,
Leningrad, U. S. S. R.

The unit used most frequently in expressing the results of field experiments in economic entomology is the percentage, such as the percentage mortality, the percentage infestation, etc. Usually these experiments have not been planned so as to include an objective estimate of the experimental error but recently several writers[1] have attempted to correct this deficiency by means of the analysis of variance. Although the analysis of variance probably serves this purpose better than any other method, it was not developed originally for use with percentages and it is desirable to examine this application somewhat more closely.

Two essential features of the analysis of variance are (1) that the plots containing different treatments are exposed equally and at random to the chance of experimental error, and (2) that all contributions to the net experimental error are pooled to give a single estimate of its magnitude, with which the variation due to treatment can be compared. Presumably the portion of this error coming from each plot is independent of the treatment to which it has been exposed, so that all plots contribute equally. However, when the experimental results are in terms of percentages, the error is a function not only of the number of individuals upon which the percentage is based—which often can be equalized experimentally—but also of the theoretical percentage which is sampled by the observed value. If, in fact, all treatments were to produce the same percentage effect within the limits of the sampling error, so that the theoretical percentage could be taken as constant, then the pooled estimate of error would be a valid one and could not lead to incorrect conclusions. But more often the treatments will not be of equal effectiveness and in such cases the results on plots that are given some treatments will be estimated within narrower limits than the results on plots that are given other treatments.

[1]L. L. Huber and J. P. Sleesman, J. Econ. Entom., 28, 70, 1935. T. R. Hansberry and C. H. Richardson, Ia. State Col. J. Science, 10,27, 1935.

Under these circumstances a pooled estimate of error, especially in the study of interactions, may not be a reliable measuring stick. The discrepancy is further increased if a significant amount of field heterogeneity has been eliminated from the estimate of the experimental error by a randomized block or Latin square arrangement.

The information, I_p, in an observed percentage (or proportion) is by definition the reciprocal of its variance and for large samples is given by the equation

$$I_p = \frac{n}{pq},$$

where p is the theoretical or expected proportion of one type of individual, such as of dead insects after a poison spray, $q = 1 - p$ or the theoretical proportion of the alternative type, as of insects surviving the spray, and n is the number of individuals counted in determining a given percentage. The dependence of I_p upon this theoretical proportion is shown in Fig. 1, in which I_p is taken as unity when $p = 0.5$. The information contained in any observation is a minimum at $p = 0.5$ and increases rapidly as the proportion falls below 0.1 or rises above 0.9. Moreover, the theoretical proportion is not known *a priori* but is itself the object of estimation.

The most convenient way of eliminating this variability would be to transform the observed percentages to a unit that is not dependent upon the theoretical proportion but, whatever its value, contains an equal amount of information. Such a procedure would be analogous to the conversion of the correlation coefficient to the statistic z when testing significance or when combining data, as described in Section 35 of "Statistical Methods for Research Workers," by R. A. Fisher. The transformation of percentages to probits,[2] which were introduced for another purpose, would not meet our requirements, since the information on the probit scale is also dependent upon the expected proportion, although it has a maximum instead of a minimum at $p = 0.5$ (Fig. 1).

Prof. R. A. Fisher has written me that the problem can be resolved by transforming each percentage to an angle θ such that $p = \sin^2\theta$. As the proportion p varies from 0 to 1 or the observed percentage from 0 to 100, θ will change from 0° to 90°.

[2]C. I. Bliss, Ann. Appl. Biol. **22**, 134. 1935.

Then

$$q = \cos^2 \theta,$$

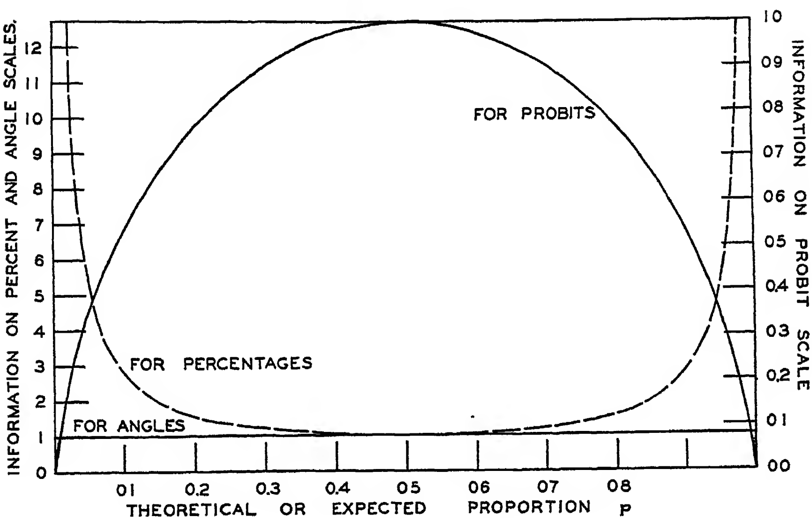
$$I_p = \frac{n}{pq} = \frac{n}{\sin^2 \theta \cos^2 \theta},$$

and

$$I_\theta = I_p\left(\frac{dp}{d\theta}\right)^2 = \frac{n}{\sin^2 \theta \cos^2 \theta} \cdot 4 \sin^2 \theta \cos^2 \theta = 4n,$$

since

$$\frac{dp}{d\theta} = 2 \sin \theta \cos \theta.$$



The value for I_θ is exact and is independent of p or θ, as indicated by the horizontal line in Fig. 1. For large samples the distribution tends to normality and consequently has the limiting variance formula $V(\theta) = \frac{1}{4}n$. In most field experiments the percentages are based upon relatively large numbers, of 100 or more individuals, so that usually the transformation would accomplish its purpose. For small samples the distribution is not normal and the effect that this may have upon the variance of the angle when n = 10 (which may be taken as a minimum) has been discussed in a recent paper by M. S. Bartlett.[3] His study shows that at this lower limit the variance is still a function of p, but not more so than is the original percentage.

[3]M. S. Bartlett, J. Roy. Stat. Soc. Supplement **3**, 68. 1936.

Although the gain would be less, the use of this transformation for samples of only moderate size should not introduce any new errors in the subsequent analysis of variance.

The usefulness of the transformation from percentages to equivalent angles depends upon the availability of tables by which the one can be converted directly into the other. It is essential for later computation in the analysis of variance that the fractions of these equivalent angles be expressed in a

TABLE I

ANGLES OF EQUAL INFORMATION ARE GIVEN IN THE BODY OF THE TABLE CORRESPONDING TO OBSERVED PERCENTAGES ALONG THE LEFT MARGIN AND TOP

	0	1	2	3	4	5	6	7	8	9
0	0	5.7	8.1	10.0	11.5	12.9	14.2	15.3	16.4	17.5
10	18.4	19.4	20.3	21.1	22.0	22.8	23.6	24.4	25.1	25.8
20	26.6	27.3	28.0	28.7	29.3	30.0	30.7	31.3	31.9	32.6
30	33.2	33.8	34.4	35.1	35.7	36.3	36.9	37.5	38.1	38.6
40	39.2	39.8	40.4	41.0	41.6	42.1	42.7	43.3	43.9	44.4
50	45.0	45.6	46.1	46.7	47.3	47.9	48.4	49.0	49.6	50.2
60	50.8	51.4	51.9	52.5	53.1	53.7	54.3	54.9	55.6	56.2
70	56.8	57.4	58.1	58.7	59.3	60.0	60.7	61.3	62.0	62.7
80	63.4	64.2	64.9	65.6	66.4	67.2	68.0	68.9	69.7	70.6
90	71.6	72.5	73.6	74.7	75.8	77.1	78.5	80.0	81.9	84.3
100	90.0									

decimal system rather than in minutes and seconds. Such a table has been computed. It will be published elsewhere in full[4] but is given here in abbreviated form. With this aid it should be possible to apply the analysis of variance without error to such field experimental data as can be expressed legitimately in percentages, even when these cover a wide range of values.

[4] C. I. Bliss, Plant Protection, No. 12. 1937. Leningrad.

Allergies

Like the farmer who enjoyed good health until he read the patent medicine almanac, the allergy susceptible person will recall his ailments as he reads this realistic treatise on allergic diseases. In brief compass are outlined causes, symptoms, diagnoses, and treatments. The list of allergy causing agents is astounding to one who has not investigated this group of diseases. Among plants the allergens read like a floral list for a typical midwestern habitat, and the animal list might be headed, "Common animals I have met." The geneticist will be impressed by the statement that more than 50 per cent of the asthma cases have an hereditary history, but detailed family histories are not included. This volume will be of interest to the biologist, the medical practitioner, and the allergic patient.

—*R. A. Hefner.*

Allergy, its Practical Application, by J. A. Rudolph, M. D. 208 pp. Dorrence, 1937. $3.00.

THE BIOLOGY OF CORYTHUCHA AESCULI O. & D. (HEMIPTERA, TINGITIDAE) ON THE YELLOW BUCKEYE, AESCULUS OCTANDRA MARSH[1]

WM. C. STEHR,
Department of Zoology, Ohio University

INTRODUCTION AND ACKNOWLEDGMENTS

In May, 1932, the author noticed that the leaves of the yellow buckeye, *Aesculus octandra* Marsh., were literally covered by the tingitid, *Corythucha aesculi* O. & D., and showed considerable injury due to the feeding activities of this insect. Considerable numbers of various species of lady beetles were also present feeding upon the eggs and nymphs of the tingitid. With the assistance of four undergraduate students in entomology, a study of this association of insects has been carried on from the spring of 1932 until the end of June, 1936. Mr. John H. Hughes aided in the field work in 1932 and drew the figures of the life history of *C. aesculi*. Mr. Harry Bauman aided in the observations in 1933 and the spring of 1934; Mr. Dwight McKeown helped in the fall of 1934 and in 1935; and Mr. Harold S. McGinnis aided in 1936. The author has made observations and directed the study throughout. Acknowledgments are due Dr. C. J. Drake, of Iowa State College, for checking the identification of *C. aesculi* O. & D. and to Dr. Herbert Osborn, of Ohio State University, for determination of the leaf-hoppers mentioned in the paper.

THE LIFE HISTORY OF *Corythucha aesculi* O. & D.

C. aesculi O. & D. hibernates in the adult stage. It has been found under the bark of oak, hickory, and yellow buckeye, at a considerable distance above the ground. It has not been found on the lower part of tree trunks, stumps, logs, under debris or leaves, or in crevices. The number of this species found in hibernation is not a true indication of the number that appears on the leaves of buckeye in the spring, so there is probably still an undiscovered niche for hibernation in which large numbers spend the winter.

[1]Paper No. 13 from the Department of Zoology, Ohio University, Athens, Ohio.

The yellow buckeye is among the first of the forest trees of southeastern Ohio to acquire foliage in the spring and usually its leaves are quite well-developed before the leaf buds of most other trees open. Thus it becomes a concentration point for insects as they come out of hibernation. The adults of *C. aesculi* assemble on the buds of the yellow buckeye as soon as they begin to open. Often the opening buds will be literally covered by the tingitids before the leaves have a chance to spread. Feeding begins immediately and goes on continuously to the end of the season.

TABLE I

SEX RATIO of *C. aesculi* O. & D.

DATE	TOTAL SPECIMENS EXAMINED	MALES	FEMALES	SEX RATIO
April 26, '33	466	99	367	79—
" 27, '33	435	95	340	.78+
" 29, '33	450	120	330	.70+
May 1, '33	414	94	320	78—
" 3, '33	463	103	360	78—
" 16, '33	85	14	71	84+
June 10, '33	250	68	182	73—
May 20, '35	200	61	139	70—
June 15, '35	425	112	313	71+
July 22, '35	346	81	265	77—
June 26, '36	328	78	250	76+
Totals	3,862	925	2,937	.76+

Females of *C. aesculi* greatly outnumber the males as is shown in Table I compiled from samples swept from the trees on various dates. The sex ratio is approximately .76. In cage experiments one male will mate with several females, and one female will mate with several males. This probably occurs in nature also.

When the weather is warm copulation is in progress in the field within two days after the emergence from hibernation and continues for several weeks. Oviposition commences about two days after copulation and continues about three weeks. The eggs are partially inserted in the tissues of the under side of the leaves along the principal veins. (Fig. 1). The numbers of eggs deposited per leaflet may be enormous. Counts of the eggs on 200 leaflets during the peak of the oviposition period gave an

average of 322 eggs per leaflet (one leaflet of the five of a leaf). Table II summarizes the results of these counts.

Five females in cages deposited an average of 178 eggs each over a period of ten days. The maximum number was 297, the minimum was 64. We have no record of the number laid per female in the field, but judging from the number of eggs on the leaflets, it is quite large.

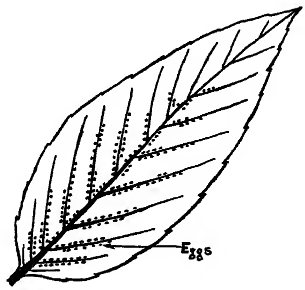


Figure 1. Leaflet of yellow buckeye, *Aesculus octandra* Marsh., showing the position of eggs of *C. aesculi* O. & D.

The eggs hatch in from six to twelve days dependent upon the weather conditions and the young of each brood begin feeding in colonies on the under surface of the leaves. Sometimes three or four such aggregations will be found on a single leaf. The individuals of each aggregation are of the same instar although different aggregations may be in different instars. These aggregations of the same age remain together until they metamorphose into the adult stage. One may often find the exuviae of all instars of the group attached to the same leaf.

TABLE II

The Number of Eggs of *C. aesculi* O. & D. per Leaflet of Yellow Buckeye

Date	Number of Leaflets Examined	Number of Eggs Per Leaflet
May 1, '33	10	186
May 2, '34	40	278
May 15, '36	150	342
Total	200	Average 322

The number of individuals feeding on one leaf varies a great deal but may reach relatively large figures at times. Table III summarizes the counts of tingitids feeding upon the leaves of the buckeye at various times.

The length of time spent in the different instars varies with the weather conditions. High temperatures accelerate development, as is to be expected; low temperatures retard it. Warm dry weather is most favorable to the rapid and complete development of the broods. The spring months of 1932, '33, and '34, were warmer than those of 1935 and '36 in this area. Table IV

TABLE III

THE NUMBERS OF ADULTS AND NYMPHS OF *C. aesculi* O. & D. FEEDING PER LEAF (FIVE LEAFLETS) OF YELLOW BUCKEYE AT VARIOUS TIMES

(Each figure is the average of the counts on 100 leaves chosen at random.)

Date	Adults	Nymphs	Totals
May 7, '32	41	0	41
" 23, '32	28	136	164
June 27, '32	7	158	165
May 18, '33	36	140	176
" 31, '33	12	61	73
June 3, '34	27	96	123
May 19, '35	17	0	17
July 6, '35	4	48	52
June 26, '36	129	13	142

shows the effect of this difference distinctly upon the development of the tingitids. Heavy rains accompanied by strong winds frequently wash and blow large numbers of nymphs from the trees and thus reduce the populations materially. On May 25, 1933, for example, 2.77 inches of rain fell in the area within a few hours. Table III shows a population of 176 per leaf on May 18 and of 73 per leaf on May 31. A number of such instances when smaller numbers of leaves were counted appear in our records.

The total time from the deposition of eggs till the adult stage is reached is between six and seven weeks for the spring brood and slightly less for the summer brood. Table IV gives the dates of emergence from hibernation, the periods of copulation and oviposition, and the periods during which various instars were present in the field for both the spring and summer

broods. The dates are the first and last days on which the various stages were observed in the field. Since at times one or two days elapsed between observations, the actual appearance

TABLE IV

SEASONAL HISTORY OF *C. aesculi* O. & D. THE DATES REPRESENT THE FIRST AND LAST DAYS OF EACH YEAR UPON WHICH STAGES WERE OBSERVED IN THE FIELD

Year	Date of Emergence from Hibernation	Period of Copulation	Period of Oviposition	1st. Instar Present	2nd. Instar Present	3rd. Instar Present	4th. Instar Present	5th. Instar Present	Adult Present	Brood
1932	?	? to May 7	? to May 10	? to May 16	May 8 — May 23	May 14 — May 31	May 21 — June 6	May 26 — June 12	June 2 — July 5	
1933	Apr. 17	Apr. 18 — May 2	Apr. 20 — May 6	Apr. 26 — May 14	May 3 — May 22	May 9 — May 29	May 16 — June 8	May 22 — June 15	May 28 — July 8	
1934	Apr. 18	Apr. 20 — May 5	Apr. 21 — May 7	Apr. 30 — May 15	May 7 — May 23	May 13 — May 31	May 20 — June 6	May 28 — June 13	June 6 — July 6	SPRING
1935	Apr. 29	May 1 — May 20	May 4 — May 27	May 15 — June 4	May 24 — June 11	June 2 — June 26	June 11 — July 4	June 19 — July 11	June 26 — July 22	
1936	Apr. 23	Apr. 25 — May 16	Apr. 29 — May 24	May 12 — June 3	May 19 — June 11	May 27 — June 16	June 3 — June 21	June 10 — June 28	June 17 — ?	
1932		June 3 — June 11	June 4 — June 14	June 9 — June 20	June 14 — June 25	June 20 — July 2	June 28 — July 10	July 5 — July 18	July 12 — Sept. 17	
1933		May 29 — June 10	May 31 — June 12	June 7 — June 19	June 13 — June 27	June 20 — July 5	June 27 — July 12	July 6 — July 20	July 13 — Sept. 23	
1934		June 8 — June 19	June 9 — June 22	June 16 — June 30	June 23 — July 8	June 30 — July 15	July 6 — July 23	July 12 — Aug. 1	July 17 — Oct. 2	SUMMER
1935		June 27 — July 6	June 28 — July 9	July 5 — July 15	July 10 — July 23	July 16 — July 31	July 22 — ?	July 27 — ?	Aug. 3 — Sept. 25	
1936		June 19 — ?	June 20 — ?	June 26 — ?	Observations discontinued					

or disappearance of the stage may in a few cases be a day or two earlier or later than given. However, observations for the five years check rather closely with each other and it is believed

that the record as a whole is quite accurate. Figure 2 shows the life cycle diagrammatically for the year 1933.

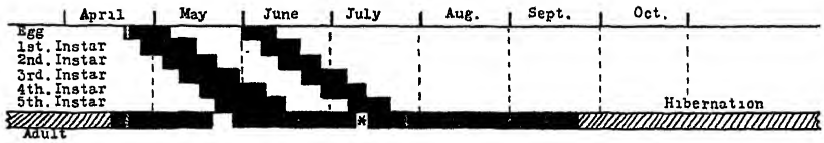


Figure 2. The stages of *C. aesculi* O. & D. present in the field at various times during a typical season. Based on the records of the year 1933. *Spring and summer brood possibly overlap at this time.

Table V gives the average duration of the various instars and Table VI gives their average length in millimeters. Figure 3 shows the egg, the five nymphal instars, and the adult of *C. aesculi*. These figures were all drawn to scale under a compound microscope by Mr. John Hughes. These tables and figures are self-explanatory and need no further discussion.

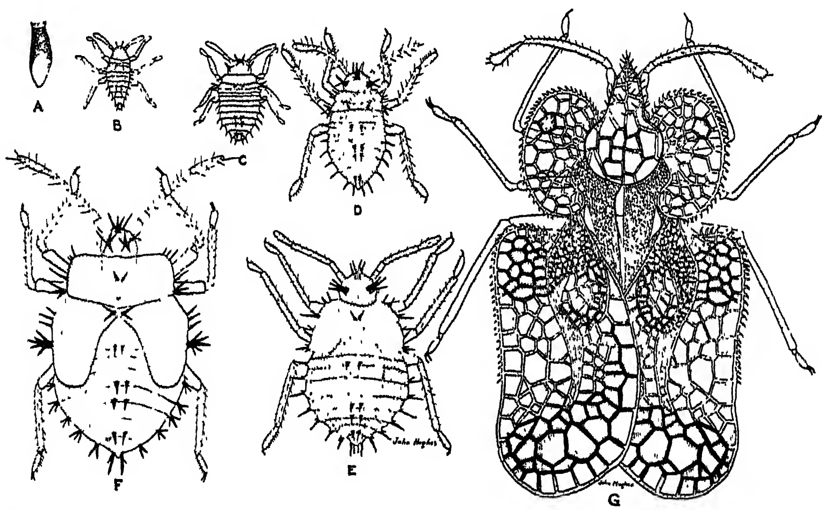


Figure 3. Various stages in the development of *C. aesculi* O. & D. A, egg; B, 1st instar; C, 2nd instar; D, 3rd instar; E, 4th instar; F, 5th instar; G, adult. All stages are drawn to the same scale.

The spring brood develops in much greater numbers than the summer brood for several reasons. The food supply as a rule is much more abundant and succulent in the spring, whereas the summer brood appears at a time when the spring brood has already inflicted heavy injury upon the preferred

portions of the food plant. Many leaves become dry and drop from the trees carrying with them eggs and young nymphs of the summer brood. These usually do not get back to the host plants. Predators are also more abundant when the second brood appears and take a greater toll from it.

TABLE V

DURATION OF THE VARIOUS INSTARS IN THE DEVELOPMENT OF *C. aesculi* O. & D. IN DAYS; BASED ON FIVE-YEAR RECORDS

Stage in Development			Egg	Nymphal Instars					Adult
				1st.	2nd.	3rd.	4th.	5th.	
Length in Days	Spring Brood	Range .	6–13	7–9	5–15	7–9	5–8*	6–9	26–42†
		Mean	8 8	7.6	7 7	7 7	6 8*	7 2	35†
	Summer Brood	Range	5–7	5–8	6–8	6–8	5–8	5–7	Overwinters
		Mean	6 8	6 5	7 0	7 1	7 1	6 3	

*The 4th instar of the spring brood is of shorter duration than any of the other instars of the brood. This does not hold for the summer brood.

†It may be that some individuals of the spring brood survive somewhat longer, for after the summer brood matures it is impossible to separate individuals of the two broods.

TABLE VI

MEASUREMENTS OF THE VARIOUS STAGES IN THE DEVELOPMENT OF *C. aesculi* O. & D EACH FIGURE REPRESENTS THE AVERAGE OF TWENTY-FIVE INDIVIDUALS

Stage	Length in Millimeters
Egg	0 475–0 481
1st. instar nymph	0 64 –0 8
2nd. " "	0 88 –1 04
3rd. " "	1 2 –1 41
4th. " "	1 6 –1 84
5th. " "	2 24 –2 48
Adult	4 0 –4 4

Adults of the summer brood usually appear about the middle of July and remain in the environment in varying numbers until September or October when they go into hibernation upon the advent of cold weather.

EFFECTS ON THE HOST PLANT

The overwintering adult tingitids begin to feed upon the leaf buds of the yellow buckeye before they have a chance to open in the spring. Before long feeding scars become apparent on the under surface of the leaves. The bases of the eggs are inserted along the principal veins and a large number of scars result from this habit of oviposition. Fecal material is also deposited on the under surface of the leaves in the form of multitudinous flecks which block large numbers of the stomata. When the eggs hatch, the nymphs feed in aggregations on the under surface of the leaves and soon the entire areas where they are feeding turn yellowish and finally brown.

The spring brood feeds mainly on young trees and on the lower branches of older trees. Very few individuals are seen at heights greater than twenty feet above the ground. By July 1 most of the leaves of the young trees and on the lower branches of older trees are turned brown and begin to fall off. By the middle of July many of the young trees are nearly bare. Many of the eggs of the spring brood deposited in these leaves perish when they hatch, for the nymphs usually do not again reach a food plant. The second or summer brood develops largely from eggs deposited on leaves higher on the older trees and from the few leaves that survive injury by the spring brood and remain on the younger trees.

TABLE VII

MEASUREMENT OF GROWTH OF TWENTY YOUNG TREES, *Aesculus octandra* Marsh.

Mean Height		Mean Circumference of Trunk Two Feet Above Ground	
May 7, 1932	June 17, 1936	May 7, 1932	June 17, 1936
6 ft. 8 in.	7 ft 5 in.	2.5 in	2.7 in.

The injury to the trees is evidently not severe enough to kill but it is probably sufficient to retard growth of the trees. Table VII gives measurements on the growth of twenty young trees in the areas studied.

THE RELATION OF *C. aesculi* TO OTHER INSECTS ON BUCKEYE

Both predators and competitors of *C. aesculi* O. & D. are present. The predators are more important and consist largely of beetles. Table VIII lists the predators, their comparative

TABLE VIII

THE PREDATORS OF *C. aesculi* O. & D. OBSERVED IN THE FIELD AND THE STAGES ATTACKED BY EACH

Abundance is rated as follows: (A) abundant, 1 or more per leaf; (C) common, 1 or more per 10 leaves; (F) frequent, 5 or more observed per trip; (S) scarce, less than 5 individuals seen per trip; (R) rare, less than 5 individuals seen altogether.

FAMILY AND SPECIES	ABUNDANCE	STAGES OF *C. aesculi* ATTACKED IN FIELD
LAMPHYRIDAE:		
Lucidota atra (Fabr.)	F	Nymph 1
Photinus pyralis (L.)	F	Nymph 2
" *scintillans* (Say)	R	Not observed feeding
Photuris pennsylvanica (DeG.)	F	Nymph 1, 2, 3
CANTHARIDAE:		
Chauliognathus marginatus Fab.	F	Not observed feeding
Podabrus tricostatus (Say)	R	Nymph 1
" *basillaris* (Say)	F	Nymph 1, 2
" *modestus* (Say)	S	Not observed feeding
CLERIDAE:		
Enoclerus quadriguttatus Oliv.	R	Nymph 1
COCCINELLIDAE:		
Hyperaspis binotata (Say)	F	Egg, Nymph 1, 2, 3, 4
Brachyacantha ursina (Fab)	S	Not observed feeding
" *quadripunctata* (Melsh.)	S	Egg
Microweisea misella (Lec.)	S	Egg, Nymph 1
Stethorus punctum (Lec.)	S	Egg
Scymnus fraternus Lec	A	Egg, 1, 2, 3, 4, 5
" *rubricauda* Csy	C	Egg, 1, 2
" *collaris* Melsh	F	Egg
" *puncticollis* Lec	S	Egg
" *punctatus* Melsh.	R	Egg
" *flavifrons* Melsh	S	Egg, 1
Delphastus pusillus (Lec.)	A	Egg
Psyllobora 20-maculata (Say)	A	Egg
Ceratomegilla fuscilabris (Muls.)	F	Egg, 1, 2, 3, 4, 5, Adult
Hippodamia convergens Guer	F	Egg, 1, 2, 3
Neoharmonia venusta (Melsh.)	R	Egg
Coccinella 9-notata Hbst	F	Nymph 1
Cycloneda munda (Say)	F	Nymph 1, 2, 3
Adalia bipunctata (L.)	F	Egg, 1, 2, 3, 4
Chilocorus bivulnerus Muls	S	Egg
ORTHOPERIDAE:		
Orthoperus glaber Lec	C	Faeces, Egg
CHRYSOPIDAE:		
Larvae, sp. not determined	C	Nymphs 1, 2, 3, 4, 5
HEMEROBIIDAE:		
Larvae, sp. undetermined	C	Nymphs 1, 2
PENTATOMIDAE:		
Brochymena arborea (Say)	S	Nymph 5, Adult
ANTHOCORIDAE:		
Lyctocoris stalii (Reuter)	S	Egg, Nymph 1
Xylocoris cursitans (Fallen)	F	Egg
MIRIDAE:		
Camptobrochus nebulosus Uhler	F	Egg, Nymph 1, 2
ARACHNIDA:		
Synemosyna formica Hentz	F	Egg, Nymph 1, 2, 3
Dictyna foliacea (Hentz)	F	Nymph 1, 2
Two other spiders undetermined	R	Nymph 1, 2

abundance, and the stages of *C. aesculi* attacked by them. Some species of beetles that are known to be predacious on other insects although not observed feeding on *C. aesculi*, were present on the trees and are listed in the table for it is very likely that most of them do feed on the tingitids.

Of the forms studied the lady beetles form by far the most important group of predators upon *C. aesculi*, and among them *Scymnus fraternus*, *Scymnus rubricauda*, *Delphastus pusillus*, *Psyllobora 20-maculata*, and *Adalia bipunctata* are the most effective. The predators destroy large numbers of young of *C. aesculi* in all stages from the egg to the fourth instar and smaller numbers of the older stages. The toll taken from the summer brood is greater in proportion than that taken from the spring brood. The numbers destroyed are not sufficient, however, to keep the tingitid from becoming exceedingly abundant as has been shown in the preceding sections of this paper.

TABLE IX

EGGS OF *C. aesculi* O. & D. DEVOURED BY PREDATORS IN CAPTIVITY IN FOUR, FIVE, OR SIX DAYS

PREDATORS	NUMBER OF INDIVIDUALS	TOTAL EGGS CONSUMED	EGGS CONSUMED PER DAY
Scymnus fraternus Lec.	4	292	14 6
Scymnus rubricauda Csy	8	500	12 5
Delphastus pusillus (Lec.)	10	470	8 7
Ceratomegilla fuscilabris (Muls.)	3	350	25
Psyllobora 20-maculata (Say)	15	1407	17 8
Adalia bipunctata (L.)	7	851	23

A few experiments were carried out to determine the number of tingitid eggs destroyed by some of the lady beetle predators. Table IX gives the results of these.

Various parasitic Hymenoptera were observed on the foliage frequently but no oviposition was noted and no parasites were reared from any of the eggs or nymphs that were caged.

There are certain insects that attack the buckeye leaves and thus serve as competitors of *C. aesculi*. Some of these became fairly abundant at times, but at no time was their influence

great enough to bring about a shortage of food for the tingitids. Table X gives a list of those observed feeding on buckeye leaves.

Another tingitid, *Gargaphia tiliae* Walsh, sometimes occurs abundantly on the yellow buckeye during the mating season. It has never been observed to feed upon the leaves. Many other species of insects were observed on the foliage occasionally but since they were few in numbers and no feeding activity was observed, they are omitted from this discussion.

TABLE X

INSECTS FOUND FEEDING ON THE LEAVES OF THE YELLOW BUCKEYE, *Aesculus octandra* MARSH., IN COMPETITION WITH *C. aesculi* O. & D.

FAMILY AND SPECIES	ABUNDANCE
HOMOPTERA:	
Cicadellidae	
Graphocephala versuta (Say)	F
Erythroneura vulnerata (Fitch)	A
Erythroneura basilaris (Say)	F
LEPIDOPTERA:	
Geometridae.	
Larvae, sp. undetermined	F
COLEOPTERA:	
Scarabaeidae.	
Dichelonyx subvittata Lec	R
Chrysomelidae.	
Syneta ferruginea (Germ.)	S
Nodonota puncticollis (Say)	S
Paria canella (Fab.) and var	C
Diabrotica 12-punctata (Fab)	F
Diabrotica vittata (Fab.)	F
Luperodes cyanellus Lec	S
Crepidodera erythropus Melsh	A
Epitrix fuscula Cr	S
Epitrix cucumeris Har.	C
Chaetocnema minuta Melsh	C
Baliosus ruber (Web)	R
Chiridia guttata (Oliv)	F
Metriona bicolor (Fab.)	F
Mylabridae.	
Mylabris mimus (Say)	C
Curculionidae.	
Two sp. undetermined	F

SUMMARY

1. The life history of *Corythucha aesculi* O. & D. on yellow buckeye, *Aesculus octandra* Marsh., has been studied for five years and the data summarized for each stage of development.

2. The sex ratio of *C. aesculi* is approximately .76.

3. The spring brood confines its attack largely to young trees and the lower branches of older trees.

4. The summer brood develops mainly in older trees twenty or more feet above the ground.

5. Many eggs and young of the summer brood never develop because the leaves on which the eggs are laid drop from the trees and the young do not get back to their food plant.

6. Forty predators, mainly insects, were found on the buckeye trees. Most of these were observed to attack one or more stages of *C. aesculi* and thus reduce the populations of both broods. They are not effective enough to control the tingitid.

7. Six species of lady beetles have been fed upon the eggs of *C. aesculi* while in captivity.

8. Twenty-one insects have been observed feeding upon the leaves of the yellow buckeye in competition with *C. aesculi*. None of them were ever abundant enough to cause a shortage of food for the tingitid.

9. Injury to leaves of young buckeye trees causes them to drop their leaves in midsummer. This results in slow growth of the trees. Older trees seemingly suffer little injury since only the lower leaves are severely injured.

BIBLIOGRAPHY

Barber, H. G., and H. B. Weiss. The lace-bugs of New Jersey. Cir. 54, Bur. of Statistics and Inspection, N. J. Dept. of Agr., pp. 1–24, 1922.

Blatchley, W. S. Heteroptera of Eastern North America. pp. 1116. Nature Pub. Co., Indianapolis. 1926.

Osborn, Herbert, and C. J. Drake. The Tingitoidea or "lace-bugs" of Ohio. Ohio Biol. Survey 2: (4), pp. 217–251. (Bull. No. 8).

Physical Optics

Fundamentals of Physical Optics by Jenkins and White seems to the reviewer to be an excellent text for advanced undergraduates and graduate students in their early career. The contents are divided into nineteen chapters and each chapter is divided into paragraphs so numbered that reference to them is most convenient. The subject matter is illustrated very amply throughout by lucid diagrams and excellent photographs. Especially commendable are the many photographs of spectra, diffraction patterns, interference patterns and the Faraday effect. Very desirable is the long list of examples found at the end of each chapter, a feature which makes this work very useful in courses of physical optics. The material is clearly presented and is printed in clear readable type and the book may sincerely be recommended to teachers of physical optics and is a convenient reference book on the shelf of the man actively engaged in research.—*H. H. Nielsen.*

Fundamentals of Physical Optics, by F. A. Jenkins and H. E. White. xiv+453 pp. New York, The McGraw-Hill Book Co., 1937. $5.00.

RECENT EARTHQUAKES IN WESTERN OHIO[1]

JOHN T. ROUSE AND R. R. PRIDDY
Department of Geology, Ohio State University

INTRODUCTION

On March 2 (9:48 A. M.) and again on March 9 (12:45 A. M.), 1937, western Ohio and surrounding states were shaken by earthquakes of such strength as to be generally felt throughout Ohio and detected in the adjacent states of Kentucky, Indiana, Michigan, western Pennsylvania, and West Virginia. Seismographs at Xavier University at Cincinnati and John Carroll University at Cleveland recorded shocks, lasting from 2 to 3 minutes, on both of these dates.

The purpose of this paper is to describe the method employed to locate the epicenter by a non-instrument type of study and to briefly outline the pertinent geologic conditions in the vicinity of the epicenter. After each earthquake a survey of western Ohio was made dealing with the intensities of the shocks in the different regions as revealed by disturbances of objects on the earth's surface. These disturbances were in the form of property damage, movement of objects in buildings, displacement of monuments in cemeteries, and numerous other miscellaneous phenomena. Careful analysis of the displacement of objects showed that the direction of movement of the earthquake waves at specific points could be determined. Since the two earthquakes had a common epicenter and differed only in intensity, they generally will be discussed together throughout this paper.

INTENSITY OF THE EARTHQUAKES

Brief mention should be made regarding the intensities of the earthquakes before discussing the epicenter of these quakes. Since the epicenter is that surface area where the earthquake waves are felt first and where the property damage is the great-

[1]The writers wish to thank Professor J. Ernest Carman, who suggested the problem, for helpful suggestions regarding the preparation of the manuscript, and Rev. V. C. Stechschulte for profitable discussions concerning the Ohio earthquakes. We also gratefully acknowledge the helpful co-operation of Mr. George Rilling, Superintendent of Anna public schools, and other residents of the earthquake area.

est it naturally follows that a study of the relative damaging effects of an earthquake will help to delimit the epicenter. In order to have a uniform method of evaluating earthquake intensities seismologists have established certain intensity scales in which varying degrees of property damage and human reactions are grouped under specific intensity numbers. The Rossi-Forel scale, given below, is one such scale.

ROSSI-FOREL SCALE

I. *Microseismic shock*: Recorded by a single seismograph or by seismographs of the same model, but not by several seismographs of different kinds; the shock felt by an experienced observer.

II. *Extremely feeble shock*: Recorded by several seismographs of different kinds; felt by a small number of persons at rest.

III. *Very feeble shock*: Felt by several persons at rest; strong enough for the direction or duration to be appreciable.

IV. *Feeble shock*: Felt by persons in motion; disturbance of movable objects, doors, windows; cracking of ceiling.

V. *Shock of moderate intensity*: Felt generally by everyone; disturbance of furniture, beds, etc., ringing of bells.

VI. *Fairly strong shock*: General awakening of those asleep; general ringing of bells; oscillation of chandeliers; stopping of clocks; visible agitation of trees and shrubs; some startled persons leave their dwellings.

VII. *Strong shock*: Overthrow of movable objects, fall of plaster; ringing of church bells; general panic, without damage to buildings.

VIII. *Very strong shock*: Fall of chimneys, cracks in the walls of buildings.

IX. *Extremely strong shock*: Partial or total destruction of some buildings.

X. *Shock of extreme intensity*: Great disaster, ruins, disturbances of the strata, fissures in the ground, rock-falls from mountains.

The particular value of such a scale is that it enables one to submit questionnaires to residents in different parts of the affected areas and on the basis of their answers plot isoseismic maps showing the intensities of the earthquake in specific regions. The intensity will be greatest, that is highest number, in the vicinity of the epicenter and will decrease outward from this area. Such a map was drawn for the earthquakes in western Ohio and is shown in Figure 1.

The second earthquake, March 9, was of much greater intensity than the first one of March 2. This statement is readily apparent to those who experienced both shocks and is further verified by the greater property damage caused by, and

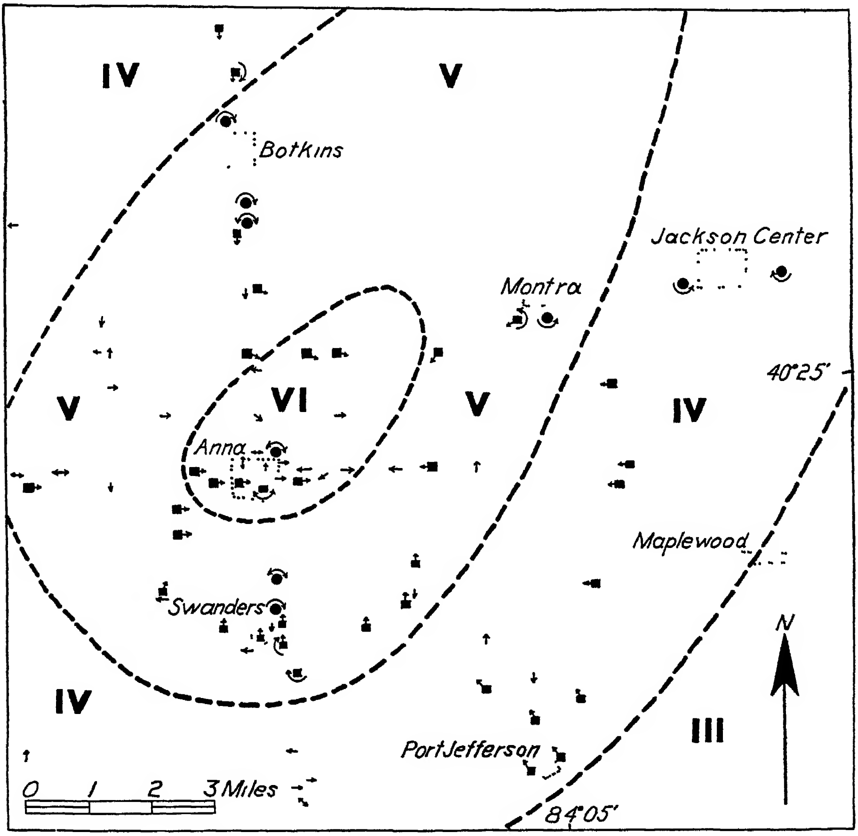


Figure 1. Isoseismic map of the epicenter and vicinity for the earthquake of March, 9, 1937. Roman numerals refer to Rossi-Forel Scale intensity numbers, the area marked VI being the epicenter. Arrows indicate direction of movement of non-fixed objects in buildings. Black squares represent chimneys, the attached arrows showing the direction they fell or the direction they leaned after the earthquake. Black circles, cemeteries, the arrows showing the direction of rotation of sectional monuments; if an arrow is present on both ends of the line it indicates that some monuments rotated clockwise, others counter clockwise. (Base map from the Sidney quadrangle.)

the seismic records of the later earthquake. A field study of the first earthquake was made before the second one occurred and after studying the second one excellent material was at hand for comparing the intensities of the two. Such a com-

parison showed greater property damage, greater rotation of heavy monuments in cemeteries, and more displaced objects after the second quake. In one of the grocery stores in the village of Anna some 300 items were shaken from the shelves by the first earthquake while the second one caused some 1300 items to fall to the floor.

At the epicenter, the earthquake of March 2 had an intensity of IV+ and the one of March 9, VI+ as measured by the Rossi-Forel Scale.

LOCATION OF EPICENTER

Various lines of evidence have been used for recording data concerning earthquakes when recording instruments are not available. These criteria are well summarized in Heck's book on "Earthquakes."[2] He points out that a study of the movement of objects on the earth, damage to buildings, feelings experienced by individuals, etc., must be used if the epicenter is to be delimited as occupying a certain definite area in a region. Two types of evidence were found most useful in this study in western Ohio: (1) the movement of relatively free objects as indicating the direction of wave motion; (2) the damage done to buildings, etc. It was found that the directions of movements of objects were remarkably constant for any locality and when these directions were plotted on a map (Fig. 1) they were found to radiate from a central area. Since earthquake waves reach the epicenter first and are later felt in areas surrounding the epicenter the directions of movements should radiate from the epicenter. Similarly it was found that the damaging effects were greater in the area from which these directional movements radiated.

With the foregoing in mind, some examples of movements and property damage may be examined in detail.

INTENSE DISTURBANCES

The property damage in the village of Anna, Ohio, located in northern Shelby County, was greater than in any other town affected by the earthquakes. Here the three-story brick schoolhouse was so badly damaged that building inspectors condemned it and present plans call for the construction of a new story-and-a-half earthquake-proof structure. None of the walls of the structure fell but the brick walls were severely cracked

[2]N. H. Heck: Earthquakes. Princeton University Press (1936), pp. 52–64.

and showed pronounced bulging after the quake (Plate 1). This damage was present on all walls of the schoolhouse but the northeastern corner showed greater displacement and opening of cracks than any other portion. In the same village the brick Methodist Church and one brick residence were irreparably damaged, while the belfry of the Lutheran Church was shaken down and a large interior masonry arch has been removed and replaced by one of steel construction. Practically all of the brick chimneys in Anna were damaged, being either overthrown or rotated clockwise or counter clockwise at high angles. The upper 10 feet of the 3 foot square brick chimney on top of the Anna school moved eastward 3–4 inches and rotated clockwise. The few chimneys remaining upright in Anna usually lean to the north or east. Many foundations were cracked, the filling in old wells settled, and cistern walls cracked. Within a radius of 5 miles of Anna approximately three-fourths of the chimneys required repair. In this zone of intense disturbance the cost of repairing and replacing all damaged property has been estimated to be as high as $300,000.

The movement of objects in buildings and monuments in cemeteries was more pronounced in Anna and the immediate vicinity than elsewhere. In the following discussions it should be remembered that when an object in a building is displaced it does not mean that it will be displaced in the direction the earthquake wave is moving, but rather in the direction from which the wave came. Thus if an object is said to move east with reference to the support on which it rests it means that the earth tremor moved the support west. If a coin is placed on a book and the book is struck at one end the coin will move towards that end which received the impact.

In one of the groceries in Anna a large counter ($20' \times 3' \times 2'$) and a stove weighing 600 pounds moved westward 1—2 inches and heavy laboratory tables as well as filled bookcases in the Anna school moved from 2 to 4 inches in the same direction. Stoves, refrigerators, and bookcases moved east in some houses, north in others, and south in a few residences. Heavy stone steps in front of the Lutheran Church moved 3 inches to the north.

All objects did not move in the same direction in Anna. Lighter objects, as well as heavy ones, show diversified movements. In the Anna public school each room had a radio loud speaker resting on a small shelf above the blackboards. These

speakers were all moved by the earthquakes, tracing their movement in the dust on the shelves. This movement varied between ¼ and 1 inch, with north and south movements predominating over northwest and southeast movements. In the

TABLE I

ROTATIONAL MOVEMENTS OF MONUMENTS IN CEMETERIES

Locality	Distance and Direction from Anna	Age of Monuments*	Max. Rotation	Per Cent Affected
Wapakoneta	12 mi N.	New. . Old ..	0 0	0 0
Botkins (Catholic)	5½ mi. N.	New Old	10° 15°	20 40
Botkins (New Cemetery)	4 mi. N.	New	15°	35
Botkins (Old Cemetery)	4 mi. N.	Old	40°	65
Anna	(N. E. corner of village)	Old	60°	95
Anna (Old Lutheran)	1½ mi. S.	Old	30°	95
Swanders	2 mi. S.	New	15°	20
Sidney	8½ mi. S.	New. Old	0 5°	0 5
McCartyville	4 mi. W.	New . Old .	5° 15°	5 35
Schwaberow	7 mi. W , 3 mi. N.	New . . Old . .	0 10°	0 15
New Knoxville	7½ mi. W., 7 mi. N.	New Old.. ..	0 5°	0 5
St. Patricks	6 mi. W., 2 mi. S.	New . Old . ..	0 5°	0 10
Port Jefferson	4½ mi. S., 4 mi. E.	Old	5°	10
Montra	4 mi. E., 2½ mi. N.	New. Old	15° 45°	50 90
Jackson Center	6 mi. E., 3 mi. N.	New ... Old .. .	10° 20°	20 35
Uniopolis	14 mi. N., 5 mi. E.	New. .. Old ..	0 15°	0 20
Waynesfield	14 mi. N., 10 mi. E.	New.. . Old. ...	5° 15°	10 20

*Old monuments refer to those in which the cement between sections is virtually absent. New monuments are those erected recently and with well cemented sections at time of the earthquake.

same building pictures on the east and west walls were tilted so that the tops of the pictures sloped south after the earthquake while pictures on the north and south walls were not tilted. In the immediate environs of Anna practically all the pendulum clocks stopped regardless of the direction they faced.

Sectional monuments in the Anna cemetery showed displacement in the form of rotational movement of one section in relation to another. This rotational movement was either clockwise or counter clockwise. Table 1 shows that the degree of rotation and the number of monuments rotated was greater near Anna than in cemeteries farther away from this village. Several lighter monuments were so severely shaken that they toppled over and fell to the ground.

On the basis of the foregoing descriptions the district of greatest damage and the strongest shocks can be confined to an area of approximately 25 square miles (see Fig. 1). The village of Anna is located toward the southwest part of this elliptical area which will be referred to as the epicenter. It should, however, be remembered that such an area is only approximate and may be larger and extend farther to the northeast and southwest. The scattered farmhouses outside of the village furnished fewer observations and correspondingly less detailed study. It is gratifying to find that the epicenter located by this non-instrument method is in complete agreement with the epicenter as determined by seismic observations. The seismic studies showed the epicenter to be located approximately 90 miles due north of Cincinnati.

LESS INTENSE DISTURBANCES

The disturbances away from the area just delimited as the epicenter were obtained directly by observations of the writers or from questionnaires filled out by the families of the school children of the Anna district. The information so obtained indicates a dying out of the intensity of disturbances as the distance from the epicenter increases. The ranges of intensity have been grouped according to the numbers in the Rossi-Forel Scale and determine the positions of the isoseismic lines around the epicenter (Fig. 1). The amount of rotation of monuments and the number of monuments affected in a cemetery decreases rapidly away from the epicenter. These are tabulated in Table 1. Light objects in buildings were displaced in an irregular area of some 100 square miles around the epicenter. North

or south movements are indicated by shelfware falling to the floor from north or south facing shelves in Botkins, 5 miles north of Anna. Little or no displacement of objects was noted at Wapakoneta, 12 miles north of Anna. A few items on shelves moved north in Sidney, 8 miles south of Anna. In these areas of smaller disturbances some pictures were tilted and a few pendulum clocks, whose pendulums swung toward the epicenter, stopped.

As the distance from Anna increases property damage decreases rapidly and is generally noted only in brick chimneys or slight cracks in the walls of buildings. To avoid long descriptions these damages have been plotted on the map (Fig. 1). On this map it will be noticed that west of Anna chimneys lean east; north of Anna they lean south; at Montra, 6 miles northeast of Anna, they lean south or west; at Port Jefferson, 7 miles southeast of Anna, north or west; and at Swanders, 2½ miles south of Anna, north or east.

Before closing the discussion of the earthquake intensities some interesting sidelights of the earthquakes might be mentioned which include: change of water table as evidenced by renewed activity of springs; increased flow in wells; and conversion of ordinary wells to artesian wells. The 21 artesian wells of New Knoxville (12 miles northwest of Anna) showed increased flow after both quakes. A record kept of one of these wells shows the following variations in head:

Date	*Head*
Prior to 1931 quake	11′0″
After 1931 quake	15′7″
Prior to 1937	11′0″
After March 2, 1937, quake	15′4″
After March 9, 1937, quake	18′2″

A gas well, 19 miles east of Anna, drilled into the Trenton in December, 1936, showed a pressure of 175–200 lbs. before the first quake (March 2). After this quake the pressure was reduced to 30 lbs. and subsequent redrilling and shooting has brought no change.

GEOLOGIC CONDITIONS IN THE VICINITY OF THE EPICENTER

No bedrock outcrops are found in the Anna district because of the thick glacial debris which covers the Cedarville dolomite (Niagaran) to an average depth of 100 feet. Occasionally the

distance to bedrock is much greater in pre-glacial valleys which reach the Richmond shales at depths of 500 feet. Ver Steeg[3] has shown several narrow and deep filled valleys in the region, one of which underlies Anna and extends northwest to New Knoxville. Well drillers recognize this quarter mile wide belt as the "deep drive".

The following factors are suggested as possibly having some bearing on the location of the epicenters in the Anna district.

1. The region has experienced many (many as far as midwestern states are concerned) earthquakes in the past. These former earthquakes are listed below:

June, 1876—Intense.
September, 1889—Slight.
Summer, 1892—Intense.
?—1914—Slight.
October, 1925—Slight.
October, 1930—Moderate.
October, 1931—Slight.
March 2, 1937—Intense.
March 9, 1937—Very Intense.

It is interesting to note that at the time of the 1937 earthquakes the Anna public school carried $50,000 in earthquake insurance, a type of insurance carried by very few in Ohio or adjacent states. Since the earthquakes of March 2 and 9, 1937, several other small tremors have been felt in the Anna district, the last occurring on May 3, 1937.

2. The thickness of glacial drift beneath Anna is very great because of the presence of a pre-glacial, filled valley. When earthquakes occur buildings on loose, unconsolidated material will be more seriously affected than those built on bedrock, provided both are subjected to shocks of the same intensity. In this particular instance, however, the greatest damage is not necessarily confined to the area above the valley fill hence it follows that the damage is dependent on the location of the epicenter rather than to surficial geologic conditions.

3. The position of the epicenter may have some relation to the Cincinnati anticline but because structural studies are hampered by the thick covering of glacial drift such a relation cannot be proved or disproved. There is some faulting of considerable magnitude to the north in Wood County[4] but no faults have been found in close proximity to the epicenter.

---

[3]Karl Ver Steeg: The Buried Topography of Western Ohio, Jour. Geol., Vol. 44 (1936), pp. 918–939.

[4]J. E. Carman and Wilber Stout: Relationship of Accumulation of Oil to Structure and Porosity in the Lima-Indiana Field, Problems of Petroleum Geology, Am. Assoc. Pet. Geol. (1934), (Sidney Powers memorial volume), pp. 521–529.

4. The shape of the epicenter is elliptical rather than circular with the long axis trending north-northeast. This might indicate a small linear disturbance.

5. The small size of the epicenter and the rapid decrease in intensity of the shocks away from the epicenter, as shown by the isoseismic lines, suggest that these earthquakes were of the shallow focus (10+ miles deep) rather than deep focus type.

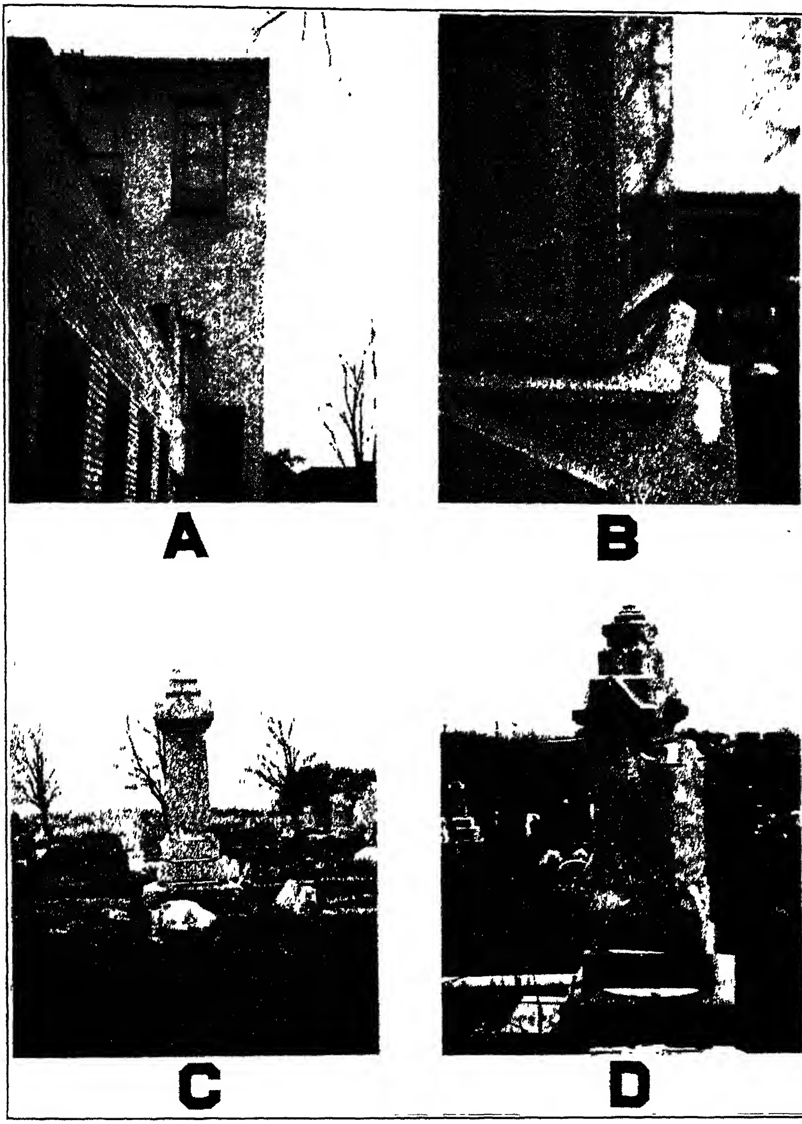
EXPLANATION OF PLATE I

A. Looking west at the northeast corner of the Anna school. Second floor portion of the wall has been displaced to the north as indicated by the cracks in the bricks and the wall pulling away from the window frame.

B. Section of recently erected monument, estimated to weigh two tons, rotated 1½ inches by the quake of March 9.

C. Ornamental urn shaken to the ground from the top of a monument in the Swanders Cemetery by the earthquake of March 9.

D. Rotational displacement of an old monument in the old Lutheran Cemetery, 1½ miles south of Anna, by the earthquake of March 2.


A
B
C
D

ALBINISM IN RANA PIPIENS (SHREBER)[1]

H. FEDERIGHI,
Antioch College, Yellow Springs, Ohio

Although extreme pallor (sometimes erroneously called albinism) in amphibians has been experimentally produced by the ablation of the hypophysis anlage in anuran embryos (*see* Hogben, 1927) true albinism occurs only rarely (Noble, 1931). During the spring of 1932 there appeared in the fish ponds of the Xenia Fish Hatchery at Xenia, Ohio, a number of albino tadpoles (*Rana pipiens*), a phenomenon which so far as is known, had never before occurred there. Twenty-three of these animals were successfully carried through metamorphosis (Figure 1) by isolating them in a screened portion of one of the ponds, but none was reared through the following summer (Langlois, 1933)[2]. At that time the author was doing some work on the color changes in tadpoles (Federighi, 1934) and so a request for some animals was made, but by that time all were dead.

During the spring of 1934, however, another group of albino tadpoles were noted and four specimens were brought to this laboratory where the skin was examined microscopically.

In its natural live state the tadpole is a light golden yellow, with pink eyes and no black skin pigmentation (Fig. 2) and in all external respects excepting pigmentation the animal seems normal.

Microscopic examinations of the skin shows the complete absence of melanophores (Fig. 3) indicating very clearly that the albinism is due to a lack of black pigment cells and not to melanophores with pigment in a concentrated state.

What has caused this albinism is problematical. According to Haecker (1908) the albino axolotl differs from the normally colored animal by a single Mendelian factor, and Woronzowa (1929) has reported that the implantation of pituitary tissue into the albino race of axolotl caused pigment to develop. Diet may in some cases affect pigmentation but not in this case, because albino and normal tadpoles occur side by side. It is

---

[1]Identified by Mr. Thomas of the Ohio State University Museum.

[2]Private communication.

interesting to speculate what may be the relative importance of each of these factors; heredity, hormones and diet. The facts that the larva goes through normal metamorphosis and, as mentioned above, that the albino animals have a common diet with normal animals seem to indicate that hormones and diet can play only a small part in this phenomenon. Thus we are forced to the conclusion that heredity is the most important if not the controlling factor. The author hopes to continue this work in order to answer these questions more fully.

LITERATURE CITED

Federighi, H. 1934. Color changes in transplanted tadpole skin. Physiol. Zool., Vol. 7, pp. 271–278.

Haecker, V. 1908. Ueber Axoltolkreuzunger; II, Mitteilung (Zur Kenntnis des partiellen Albinismus). Verh. deutsch. Zoöl. Ges., Bd. 18, pp. 194–205.

Hogben, L. T. 1927. Comparative physiology of internal secretion. Cambridge University Press. 148 pp.

Noble, G. K. 1931. The biology of the amphibia. McGraw-Hill Book Co. x+577 pp.

Woronzowa, M. A. 1929. Morphogenetische Analyse der Färbung bei weissen Axolt Axolotln. Arch. Entw. Mech., Bd. 115, S. 93–109.

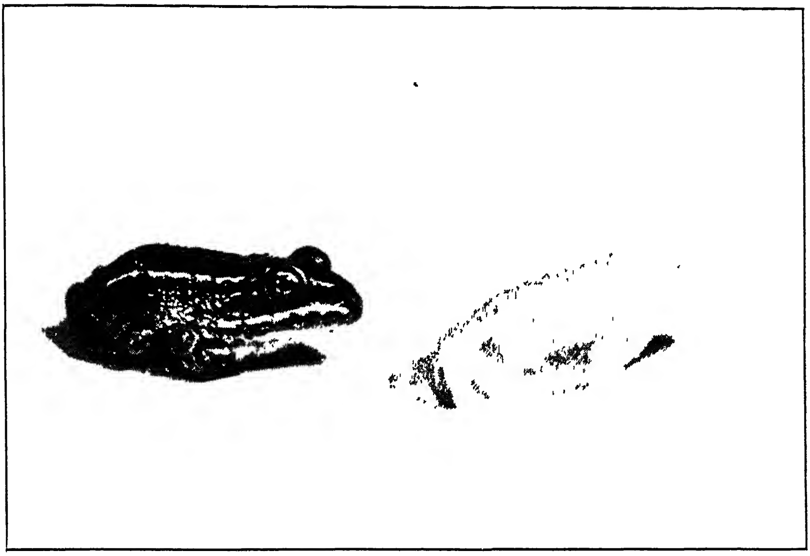


Figure 1. Adult normal and albino frogs The albino as a tadpole was collected during the spring of 1932. Live specimens.

Figure 2. Normal and albino tadpoles The albino was collected during the spring of 1934. Preserved specimens. The normal tadpole is *Rana catesbeiana*.

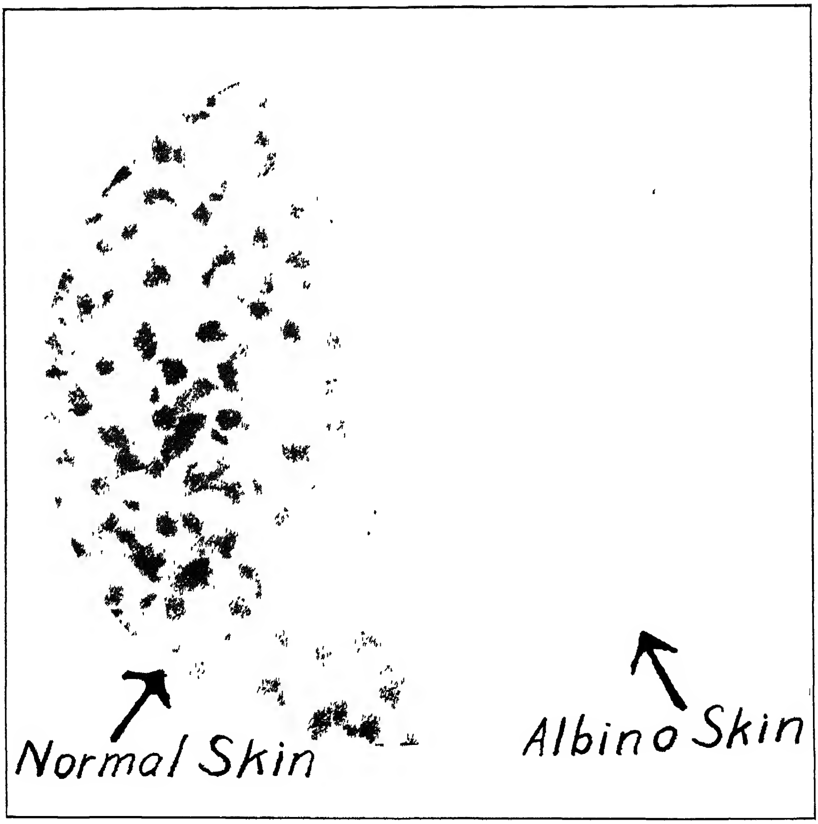


Figure 3. Photomicrograph of the tails of tadpoles shown in Figure 2. Note the entire absence of melanophores in the albino skin.

SOME NEW SPECIES OF TEXANANUS AND PHLEPSIUS FROM THE UNITED STATES

DWIGHT M. DE LONG
Ohio State University

Certain species of the Phlepsius group of genera have been confused and often two or more placed under a single name as a result of the use of external characters alone for the separation of species. The characters presented by the oedagus alone are excellent for the separation of these species and are frequently quite diverse in closely related species or two which may appear superficially to belong to the same species.

Texananus superbus Uhler

This species was described from specimens from North Carolina and Arizona. Two species were undoubtedly confused in this type series. The North Carolina specimens are therefore designated as the types and North Carolina is specified as the type locality. The oedagus is composed of three processes. The lateral pair are rather long, straight processes broadened on the basal two-thirds as seen in lateral view with the apical third tapering and decidedly narrowed. Other specimens have been examined from Tennessee and southern Illinois.

Texananus gladius n. sp.

Resembling *ovatus* in general appearance but with a long, broad, blade-like ventral oedagus process. Length, 5 mm.

Vertex bluntly angled, two-thirds as long on middle as width between eyes at base.

Color: Vertex, pronotum and scutellum yellowish, a pair of dark spots on disc of vertex. Elytra heavily marked with ramose pigment lines, posterior margin along scutellum and commissural line pale.

Genitalia: Female last ventral segment broadly, shallowly excavated with a short V-shaped notch at center. Male valve short, broadly triangular, male plates broader than long, broadly rounded. Oedagus composed of a dorsal process which is twice curved concavely upward. The caudal half more strongly curved with a slender upturned apex. Ventral portion protruding beyond apex of abdomen. In lateral view broad, blade-like and slightly concave upward.

Holotype male from Huachuca Mts., Arizona, August 18, 1936; allotype female, Gillespie Co., Texas, June 14, 1934, and male and female paratypes, Gillespie Co., same date, all collected by J. N. Knull, are in the author's collection.

Texananus angus n. sp.

Resembling *superbus* in form and appearance but narrower, paler in color and with more slender lateral processes in oedagus. Length, 6–6.5 mm.

Vertex as in *superbus* roundly angulate, produced, one-third longer on middle than next the eyes.

Color paler than in *superbus*. Ramose lines on elytra pale and fewer in number. Dark marking at end of claval veins paler.

Genitalia: Female last ventral segment broadly angularly excavated almost to base. Male valve short, narrow, and rounded. Plates broad, rather short and bluntly pointed at apex. Oedagus with three processes as in *superbus* but side processes shorter and much narrower in lateral view. Pygofers shorter and more rounded at apex.

Described from a series of male and female specimens from Uvalde, Texas, May 23, 1935; Gillespie Co., Texas, May 2, 1935, collected by J. N. Knull; Wellington, Kansas; and Roff, Cheyenne, Elser, Lebanon, and Page, Oklahoma, collected by Standish and Kaiser.

Holotype male, Uvalde, Texas; allotype female, Cheyenne, Oklahoma, and male and female paratypes in author's collection.

Texananus vermiculatus n. sp.

Resembling *superbus* in form and coloration but with long vermiculate forked lateral processes on oedagus. Length, 6 mm.

Vertex produced, blunt, rounded, almost twice as wide between eyes as median length.

Color: Yellow reticulate with brown, three brown spots on disc of scutellum and posterior ends of claval veins black.

Genitalia: Female last ventral segment rather long, deeply rather sharply excavated almost to base forming a V-shaped notch which is widened at apex. Male valve broadly triangular, male plates broad, strongly rounded to slightly pointed apices. Oedagus with three processes. The central process is short and curved dorsally, the lateral processes are long curved dorsally then ventrally at apex. A short, branched process arises at about one-third the distance to apex.

Holotype male and allotype female, Chiricahua Mts., Arizona, July 14, 1936, by J. N. Knull. Paratypes same place and date. Also from Davis Mts., Texas, August 22, 1936; Tucson, Arizona, July 27, 1936, and Wickenburg, Arizona, July 8, 1937, all collected by J. N. Knull, and in the author's collection.

Texananus manus n. sp.

Resembling *superbus* in general form and appearance but with broadened apices on lateral processes of male oedagus. Length, 6.5 mm.

Vertex produced and bluntly angled, two-thirds as wide between eyes as median length.

Color paler than *superbus* with black markings at ends of claval veins along posterior margin of elytra.

Genitalia: Male valve triangular with blunt apex, plates broad, rounded, pygofers longer than plates. Oedagus with a central dorsal

process as in *superbus*, lateral processes wide and in lateral view with apices broadened and notched producing finger-like processes which extend dorsally, ventrally, and caudally.

Described from a series of male specimens from Hualpai Mts., Arizona, July 4, 1937, collected by D. J. and J. N. Knull; Huachuca Mts., Arizona, June 9, 1935, by J. N. Knull; and one specimen labeled California without date.

Holotype male, Hualpai Mts., and male paratypes in author's collection.

Phlepsius rossi n. sp.

Resembling *fulvidorsum* in color and general appearance but slightly larger and with distinct genitalia in both sexes. Length, 7.5 mm.

Vertex produced and bluntly angled, one-half longer on middle than next the eyes, margin of vertex sharply angled with front.

Color: Vertex, pronotum and scutellum buff or dull yellow. Vertex rather heavily irrorate with brown on margin at apex and either side of middle. Pronotum rather heavily irrorate, especially on disc. Scutellum scarcely irrorate, two conspicuous brown spots on lateral margin at either side. Elytra pale, heavily irrorate, appearing brown. Inner ends of anterior claval veins white along commissural line.

Female last ventral segment rather long, posterior margin produced and margined with brown either side of a rather broad, shallow V-shaped notch. Male valve triangular, plates long, gradually tapering to narrow blunt apices. Oedagus in ventral view rather broad, apical half directed dorsally, apex with four terminal slender processes. The central pair are long and form the terminal portion of the oedagus, the lateral pair are short. A heavy process arises at the apex of each pygofer and curves across the opposite side, the apex of which is enlarged and bears a spine which extends ventrally and anteriorly.

Described from a series of one female and five male specimens collected at Herod, Illinois, August 4, 1934, by H. H. Ross, C. O. Mohr and the author, and one male specimen collected at Portland, Connecticut, July 24, 1921, by B. H. Walden. Male holotype, Portland, Connecticut, and male paratype in author's collection. Female allotype and male paratypes from Herod, Illinois, in Illinois Natural History Survey Collection.

I take pleasure in dedicating this species to Dr. H. H. Ross.

Phlepsius electus n. sp.

Resembling *irroratus* in size and general appearance, but paler in color and with distinct male genitalia. Length, 5 mm.

Vertex produced and bluntly angled, one-half longer at middle than next the eyes. Margin thin, vertex sharply angled with front.

Color: Vertex, pronotum and scutellum cream colored, rather evenly mottled with light brown. Elytra white, sparsely irrorate with dark brown.

Genitalia: Male valve broadly triangular, plates about as long as combined width at base, gradually tapered to blunt apices. Oedagus with a ventral and dorsal portion. The ventral portion in lateral

view is narrow at base and strongly abruptly broadened on apical third with a short dorsal process at apex. The dorsal portion is directed dorsally at base, then curved posteriorly and consists of two lateral pieces which diverge at apex and exceed the ventral portion in length. Pygofer with a short, erect spine on dorsal apical margin, either side.

Described from two male specimens collected in Shannon Co., Missouri, September 8, 1930, and Apple River Canyon State Park, Illinois, July 11, 1934, the latter by T. H. Frison and the author.

Holotype male (Missouri) in author's collection. Paratype male, Apple River Canyon, Illinois, in Illinois Natural History Survey collection.

Phlepsius certus n. sp.

Resembling a pale *irroratus* in general appearance but with vertex more evenly rounded and oedagus entirely different in form. Length, 5.5 mm.

Vertex almost parallel margined, three times as wide between eyes as median length, bluntly angled with front.

Color dull yellow, rather evenly marked by pale ramose pigment lines. Two darker spots along posterior margin of elytra. One is located at end of claval suture and one about half way between this and apex of scutellum.

Genitalia: Male valve short, broadly bluntly angled. Plates long, broad at base, slightly concavely narrowed about half way to apex which is bluntly pointed. Oedagus in lateral view curved upward near base, then bifurcate, a short process extending dorsally and a broad longer process directed caudally, the latter narrowed near apex. Pygofers with a long spine at the ventral caudal margin of each which is directed dorsally.

Holotype male, Wingra Lake, Wisconsin, July 8, 1916, collected by H. K. Harley, in the collection of the author.

Quantum Mechanics

In his new book which consists of five parts in addition to a preface and a chapter of introduction, Professor Lande has given what must be acknowledged as a clear and concise discussion of the principles of quantum mechanics. In the preface is stated the general purpose of the work and acknowledgment is made to the sources (especially Heisenberg's "The Physical Principles of the Quantum Theory") from which certain of the illustrations are drawn. Part I is expended to the elementary theory of observation or the principle of complimentarity and use of the principle is made to obtain the laws of quantum mechanics. Part II concerns itself with Heisenberg's uncertainty principle, while Part III is devoted to the principle of interference and to the equation of Schrödinger. The fourth part gives a development of the transformation theory as applied to quantum mechanics and considers the relation of the quantum mechanics to classical mechanics. In the mathematical appendix which constitutes Part V, the author treats the invariance of the matrix elements of quantum mechanics to canonical and unitary transformations.

Because of simplicity and clarity of style, Lande's "Principles of Quantum Mechanics" can enthusiastically be recommended to students who desire to obtain a knowledge of the underlying principles of the theory.—*H. H. Nielsen.*

Principles of Quantum Mechanics, by Alfred Lande. xii+117 pp. New York, The Macmillan Co., 1937. $2.25.

A NEW CIXIUS FROM OHIO
(Homoptera: Fulgoridae)

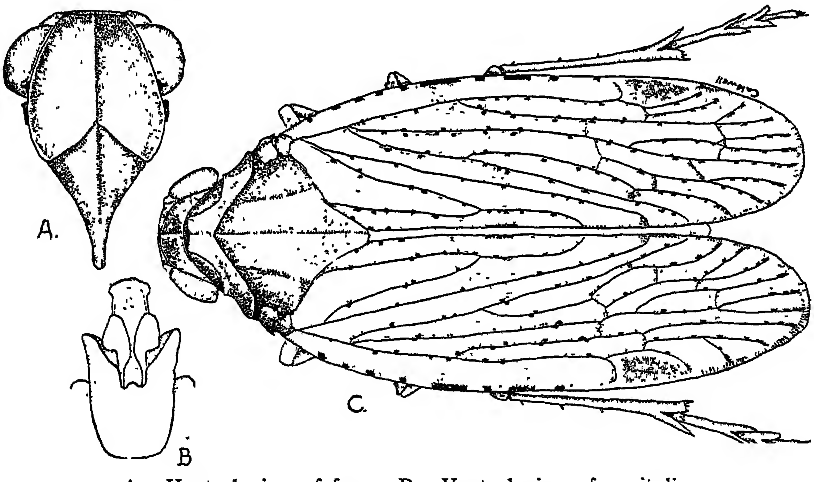
JOHN S. CALDWELL
Ohio State University

Cixius angustatus n. sp.

Length to tip of forewing, 5.2 mm.; forewing, 4.5 mm.

Vertex transverse, arcuate on both cephalic and caudal margins, resembling *pini* and *guttulatus*, median length equal to about one-third width at middle of caudal margin; median carina present. Frons broader than median length; prominent median carina present. Pronotum with median carina; caudal margin obtusely angled. Mesonotum with three prominent carinae; lateral carinae divergent caudally.

Caudal margin of pygofer broadly rounded in lateral aspect; ventral sinus broadly concave around small median tooth. Styles similar to *stigmatus* in ventral aspect except less broadened apically; broadly truncate on apical half of dorsal margins in lateral aspect. Anal segment narrow, short.



A.—Ventral view of face. B.—Ventral view of genitalia.
C.—Dorsal view of entire specimen.

General color blackish. Median carina of front yellowish; clypeus and frons concolorous; vertex black except white spot on either side next to eyes. Pronotum blackish fuscous; carinae slightly lighter; carinae of mesonotum and area between dark brown, rest of mesonotum black. Femora and tarsi dark fuscous; tibiae pale. Forewings milky hyaline, fumed basally, especially along costal margins; center of apical cells strongly fumed; a transverse band present about half way to stigma, broadening toward commissural margin; veins with dark punctures.

Male holotype from Scioto Co., Ohio, May 10, 1935, is in the writer's collection at Ohio State University.

BOOK NOTICES

Elementary Chemistry

The idea stated in the preface that this book results from a course "developed to emphasize the applications of chemistry, and designed to meet the need of the student who desires the chemical fundamentals in practical form" has been closely followed throughout the text. For special groups of students needing only a realization of the relationship between chemistry and their chosen profession, the work is excellent. As might be expected, the book does not consider to any extent the principles involved in most of the discussion. For that reason it would be very unsuitable for a general course in chemistry. The first half of the book deals with the fundamental nature of matter, inorganic substances, water, acids, bases, salts and solutions. The latter half discusses the important practical points about organic and physiological chemistry under the topics carbon and its compounds, foods and digestion, body fluids, textiles and cleaning of materials. This part is of especial value for nurses. The book is well printed on fine paper and well bound. The number of illustrations is small but well chosen.—*L. L. Quill.*

Elementary Chemistry, by Imo P. Baughman. 296 pp. Philadelphia, Lea and Febiger, 1937. $2.75.

Physics for Engineers

This work is a third edition of a physics text of the same name and is divided into two volumes; the first on Mechanics and Heat, suitable for a first semester of college physics for engineering students; the second, treating Sound, Electricity and Light, suitable for a second semester.

This work is quite lucidly written, plentifully illustrated with diagrams and actual photographs and demands no further mathematical equipment beyond the algebra. As the title implies, this work is especially suitable for students of technical subjects; many practical applications of the principles set forth being emphasized. The subject matter is, however, strictly classical physics; while the reviewer is fully conscious that little time is available in a course of this type for discussion of modern physics, it still seems unfortunate not to give to engineering students also a feeling of what modern physics treats and what its possible importance might be also in technical fields. Aside from this detail the work appeals to the reviewer and is sincerely recommended.—*H. H. Nielsen.*

Physics for Technical Students, by W. B. Anderson. 3rd ed., 2 vols. New York, The McGraw-Hill Book Co., 1937. $2.50 per volume.

Early Man

Laymen, scientists in other fields and even anthropologists themselves tend to feel confused and quickly "behind the parade" as the evidence concerning man's origin and early development rapidly accumulates. To all such persons, scientifically interested in the problems of human antiquity, this book is heartily recommended. It consists of the papers read before the International Symposium on Early Man held last March on the occasion of the 125th anniversary of the founding of the Philadelphia Academy of Natural Sciences. Thirty-five leading authorities, all actively engaged in actual field research, from all parts of the world, have contributed highly condensed reports of their latest researches and views. Consequently the volume contains a survey of scores of articles previously printed in many languages as well as a wealth of previously unpublished material. Sir Arthur Keith, the eminent British anatomist, carried the burden of summarizing such material for twenty years in his series of works dealing with human antiquity, the latest of which, "Recent Discoveries Relating to the Antiquity of Man," appeared in 1931. The subject has now progressed beyond the powers of any one man's

efforts, I believe, and it is to be hoped that volumes such as the present one will appear in the future at intervals of not less than five years.

The present reviewer's only serious complaint has to do with the grouping of the contributions in the book by chronological order of presentation rather than by subject. For instance, it would have been more helpful to have placed the three articles dealing with recent finds in Java together, rather than scattering them, as is the case, at pages 23, 315, and 349, respectively.

The question of man's origin and early life is as yet imperfectly understood. But the search for evidence and the interpretation of the available data form a fascinating field of research which may yet, by clarifying our past, illuminate our present and future.—*J. P. Gillin.*

Early Man, edited by George Grant MacCurdy. 362 pp. Philadelphia, J. B. Lippincott Co., 1937. $5.00.

Atomic Physics

This second edition supersedes the first edition known under the title "Atomic Physics" and is a text useful for students whose knowledge of physics is limited to that gained from the general course. In it the authors have seen an opportunity to rectify and improve much of the material in the former presentation and to include also discussions concerning more recent developments in physics.

Like its predecessor this volume discusses from an elementary point of view such subjects as kinetic theory, the atomic nature of electricity and radiation, atomic and molecular spectroscopy, earlier and later quantum theory, relativity and astrophysics. A chapter is, however, added in this second edition which is devoted to nuclear physics and more recent experiments on the nature of cosmic rays. While the second edition has been improved and modernized in many places, unfortunately certain other places remain out of date. For example, as an illustration of the spectrum of a diatomic molecule is given the curve of Elmer Imes. It would seem only natural to include the much more recent curve of Meyer and Levin in which complete resolution of the spectrum was accomplished.

The preparation of a text on Modern Physics for a class of students of the calibre for which this book is intended is no doubt a difficult one. This work is probably as good a one as is available, although it must be conceded that to avoid the use of mathematics a great deal of the clarity and accuracy has had to be sacrificed.—*H. H. Nielsen.*

An Outline of Atomic Physics, by O. H. Blockwood, E. Hutchisson, T. H. Osgood, A. E. Ruark, W. N. St. Peter, G. A. Scott and A. G. Worthing. 2nd ed. x+414 pp. New York, John Wiley and Son, 1937. $3.75.

A Modern Darwin

To this reviewer the new volume by Dobzhansky appears to be the most significant biological book of the past quarter-century. It is a thorough exposition of the implications for evolution arising from modern genetic theory. Since Darwin, himself, was one of the very few whose major interests lay in studies of the mechanism of evolution rather than in the historical problem, genetics rather than evolutionary morphology is heir to the Darwinian traditions. The book thus treats mainly of the dynamics of evolution. The three levels of evolutionary progress are carefully discussed: first, the occurrence of mutations and chromosomal aberrations; second, their fate as determined by the dynamic regularities of the physiology of populations; and third, the fixation of the diversity already attained on the preceding two levels. "Position effects" are treated in detail. There is a thorough discussion of the effects of random variations of gene frequencies. Here the conclusion is reached that the differentiation of a species into races may take place apart from the action of natural selection. This does not at all invalidate natural selection as an evolutionary agency, however. A chapter is devoted to hybrid sterility, and the book closes with a discussion of species as natural units. The author uses beautiful English, and has an exceptionally clear and readable style.

Because of his Russian birth and education, he has made available in the book much literature which might not otherwise reach an American audience. Illustrations are provided where needed, and a fairly complete list of citations is appended.
—L. H. S.

Genetics and the Origin of Species, by Theodosium Dobzhansky. xvi+364 pp. New York, Columbia University Press, 1937. $3.60.

Thermodynamics

This is a text book admirably suited for use in an intermediate course for students preparing themselves for careers in physics, chemistry or engineering. The background required for the comprehension of the subject matter by the student, as it is here presented, is limited to a course in general college physics and one in the calculus. In this respect the author is quite zealous, all mathematical equipment not contained in the calculus being derived when the demand for it arises. The first half of this book treats the fundamental concepts of thermodynamics; for example, temperature, the first and second laws of thermodynamics, work and heat, reversibility and irreversibility and entropy. The second half has as its purpose the application of the general principles discussed in the first half to certain specific problems in physics, chemistry and engineering as the heat engine and the refrigerator, the Joule-Kelvin effect, thermo-electric phenomena and phase change. This work is useful to the beginning student in that the subject matter is treated in much more detail than is customary, most of the intermediate steps being retained. Probably in no manner can the importance of the principles set forth so well be emphasized as by the actual solution of examples depending upon them. A most commendable feature of this book is the complete list, at the end of each chapter, of examples suitable for classroom discussion. Quite enthusiastically and without reservation can this book be recommended to the college teacher as actually doing what it sets out to do.—**H. H. Nielsen.**

Heat and Thermodynamics, by Mark W. Zemansky. xii+388 pp. New York, the McGraw-Hill Book Co. 1937. $4.00.

The Ohio Journal of Science

Vol. XXXVIII MARCH, 1938 No. 2

PHYSIOGRAPHIC FEATURES OF SOUTHEASTERN OHIO

WILBER STOUT AND G. F. LAMB

Introduction

In a general way the physiographic features of southeastern Ohio, that is, the area south and east of the glacial boundary, appear complex due to the series of events that have taken place in the region. The results, largely the work of water, now appear as peneplains, straths, cuestas, stream changes, terraces, fills, and other features of less importance. Aside from water, other agencies and modifying influences are, direct and indirect action of glaciers, crustal movements, dip of strata, kind of rock on outcrop, affectibility of strata by weathering, ease of suspension, etc. The work of sculpturing the land surface began with uplift at the close of Permian time and has continued to the present. The quantity of work accomplished at different times has varied due to the agencies at work, to the intensity of the forces and to the time they were active. The area contains many features of interest.

Physiographic Features and Order of Events

The prominent physiographic factors in southeastern Ohio may be listed in the following order, beginning with the oldest.

(1) Monadnock hills and ridges, representing possible remnants of the original surface.
(2) Harrisburg peneplain, the oldest well defined erosion surface.
  A. Uplift and rejuvenation.
(3) Lexington peneplain, best developed to the west.
  B. Uplift and rejuvenation.
(4) Parker strath with Teays, Pittsburgh and Dover drainage systems developed.

C. Flooding and filling of valleys through damming by early drift sheet, possibly Jerseyan.

D. Uplift and rejuvenation.

(5) Deep stage drainage with Cincinnati, Newark and Pomeroy drainage developed.

E. Cutting of valleys much below that of the older system.

F. Advance of Illinoian ice with consequent changes.

(6) Post-Illinoian drainage with the development of the New Martinsville, Post-Illinoian Muskingum and Post-Illinoian Hocking rivers.

G. Cutting of cols and formation of new valleys.

H. Advance of Wisconsin ice with again a shift of drainage.

(7) Present drainage system of the Ohio, Tuscarawas, Muskingum, Hocking, and Scioto Rivers.

I. Removal of outwash, formation of terraces, new channels, etc.

Monadnock Hills and Ridges

Throughout southeastern Ohio many knobs and ridges stand out as monadnocks, which are elevations projecting above the surface of a peneplain. Many of these are definite and distinct. The number and distribution of these suggest that they are the remnants of a once higher level or of the original surface. In either case it was destroyed by succeeding cycles of uplift and erosion. Near the close of the Paleozoic era crustal movements resulted in the building of the Appalachian Mountains and also in the uplifting, to where erosive agencies became active, of much territory (such as the Allegheny Plateau) bordering these highlands. During the Mezozoic era that followed, these land areas were severely attacked by erosion and eventually brought to a base leveled condition. Again other cycles of uplift and erosion further reduced the highland areas, and produced the plateau surfaces as we now know them.

The monadnock hills and ridges are well distributed over southeastern Ohio, yet their crests lack uniformity, indicating that they are only mere remnants of a higher surface. In Columbiana, Jefferson, Belmont, and Monroe counties these features stand out from a peneplain with an elevation varying from 1,260 to 1,280 feet. The common average is considered at 1,270 feet.

In Columbiana County the outstanding hill, the highest in southeastern Ohio, is Round Knob located in Section 22, Madison Township, and having an elevation of 1,447 feet. It is capped with the Morgantown sandstone, a bed prominently developed to the southwest in Jefferson County. In Wayne Township west of Madison some of the high knobs which rise from 1,350 to 1,385 feet also carry the Morgantown sandstone as the cap rock. These deposits are thus outliers from the main field and have been cut off by erosion. In all, in Hanover, West, Center, Wayne, and Madison townships eleven knobs or ridges have elevations above 1,365 feet and four of them above 1,410 feet.

To the southwest of this in Jefferson County the entire area has been reduced close to the peneplain surface as the highest knob rises only to 1,388 feet and as only four are above 1,345 feet. These knobs, however, rise much higher geologically as some of them extend well up into the Dunkard series of the Permian. The upper surface of Carroll County is also well reduced as the ridge crests remain rather constantly at 1,260 feet. The only noteworthy exceptions are two knobs in Fox Township, one rising to 1,350 feet and the other to 1,370 feet. The ridges all end geologically in the Conemaugh series.

The monadnocks in Belmont County show some increase in elevation, are more numerous, and are more widely distributed. The highest knob, 1,400 feet, is in Goshen Township and the next highest, Galloway knob, 1,397 feet, in Smith Township. In all ten knobs or ridges rise from 1,350 to 1,400 feet. The rocks capping these are strata well up in the Dunkard series, the highest being shales and sandstones above the Ninevah coal.

These special features, high knobs and ridges, are most outstanding in Monroe County where six hills rise above 1,400 feet and twenty or more above 1,360 feet. Mainly the cap rocks are beds in the Greene formation of the Dunkard series, and are thus the highest strata in the consolidated rocks of Ohio. In eastern Harrison County a few knobs in Archer, German, Rumley, Lee, and Cadiz townships rise to 1,350 feet or more, the highest being approximately 1,370 feet. Most of these are capped with rocks in the basal portion of the Monongahela formation. In the western part of the area the ridge crests remain close to the 1,260–1,280 foot peneplain level.

To the west of this highland area or in Tuscarawas, Coshocton, Guernsey, Muskingum, Washington, Noble, Morgan, Athens, Hocking, Jackson, Pike, Meigs, Gallia, Lawrence and Scioto counties, the destructive agencies have been severe, the results being a basin in which few ridges rise above the 1,260–1,280 foot level and in which in large areas the general ridge crests are much below this contour. The lower plain is that of the Lexington peneplain, discussed later.

The high plain with monadnock knobs and ridges in southern Columbiana, eastern Carroll, Jefferson, eastern Harrison, Belmont, and Monroe counties constitutes the highland area of southeastern Ohio. The number and wide distribution of these elevations show that they are remnants of much additional strata that escaped complete destruction. The thickness or quantity removed is not known but was certainly more than one hundred feet, probably much more. If the Permian rocks were laid down in this area to the full thickness shown in West Virginia, then several hundred feet was lost through base leveling. The monadnocks thus appear as remnants of a higher surface that through severe erosion has lost distinctive features.

Harrisburg Peneplain

General Features

A careful survey of the highland area in southeastern Ohio in Columbiana, eastern Carroll, Jefferson, eastern Harrison, Belmont, and Monroe counties shows that most of the higher ridges reach a rather uniform elevation of about 1,260–1,280 feet. These flat surfaces on the ridges mark the position of the Harrisburg peneplain. Generally these ridges are prominently broad and flat and are the sites for towns, villages, farm homes and highways. The culture in this area is thus, in the main, on the ridges and not in the valleys or it is in direct contrast to what it is in the area to the west. The highland area of eastern Ohio with its well-developed Harrisburg peneplain is distinctive in many ways, especially physiographically.

Flushing Escarpment

The western boundary of this highland area is an outstanding physiographic feature of the region and is marked by the escarpment and the change in the pattern of the contours where the Harrisburg peneplain breaks down to the lower

Lexington level. This distinct modification is called by the writers the Flushing escarpment from the name of the village in Belmont County where the change is so conspicuously developed. Diagram 1, taken from the Flushing topographic sheet, shows this change of contour pattern very well.

The pattern east of the Flushing escarpment in this respect lacks the deep indentations of that to the west. Thus the surface east of the escarpment in contrast to that to the west has wider ridges, less direct relief, fewer small streams, and in general more uniformity. The boundary is on the old water

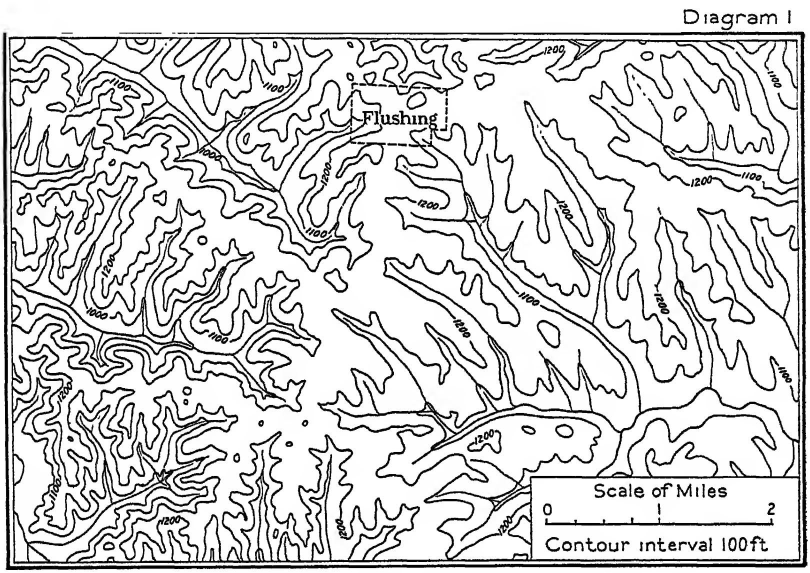


Diagram 1. Flushing Escarpment.

divide separating major streams of Teays time. This escarpment is readily traced by the change in elevation of the ridge summits and by the difference of contour pattern.

The Flushing escarpment passes from the drift border near Kensington, Columbiana County, southward through Morristown, Mechanicstown, Harlem Springs, and Kilgore, Carroll County, through Germano, Folk, and Cadiz, Harrison County, through Flushing, Morristown, Bethesda, Speidel, Barnesville, and Boston, Belmont County, and through Monroefield, Lewisville, Woodsfield, Mt. Carrick, Round Bottom, Morton and Goodwin to the Ohio River about two miles above Hannibal,

Monroe County. Along most of this course the Flushing escarpment is well and definitely defined but locally it is evidently modified, suggesting local shifting through stream advancement.

CONTRAST OF HARRISBURG AND LEXINGTON AREAS

The Harrisburg and Lexington peneplain areas show differences worthy of comment. The proportion of land above the 1,260 foot contour is much greater in the Harrisburg area than it is in the Lexington where the forces of erosion were

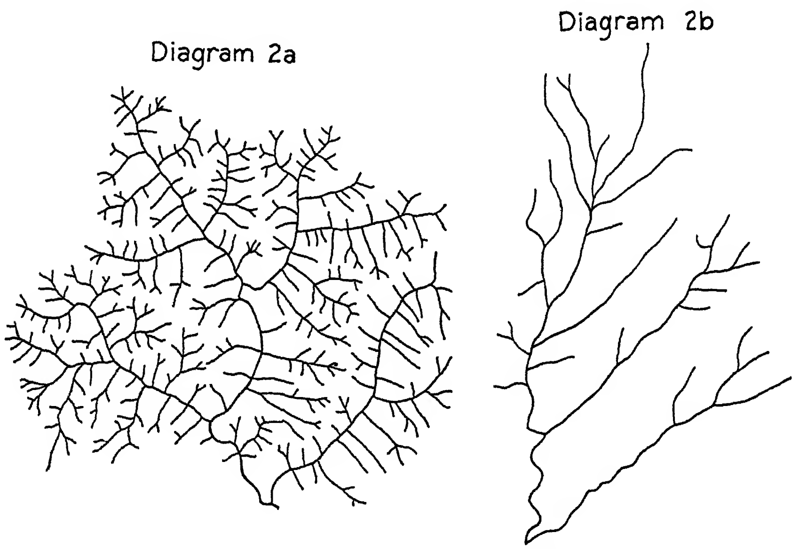


Diagram 2a. Pine Creek in Lawrence County Typical of the Lexington Area.
Diagram 2b. Baker Fork near Woodsfield in Monroe County Typical of the Harrisburg Area.

more in evidence in reducing the uplands and in dissecting the plains. The ridge flats of the former generally carry a rather definite type of soil, evidently formed in part from materials left by the degrading forces with subsequent weathering and leaching. The Harrisburg and Lexington areas are contrasted also in the patterns of the streams and in the gradients of the floors. In the Lexington area the streams have developed mature dendritic patterns whereas in the Harrisburg they are far less sculptured. This is best shown by diagrams 2a and 2b.

This dissimilarity in pattern is due to the difference of intrenchment developed by the streams from their inception to the close of Teays time. This long erosion cycle thus gave

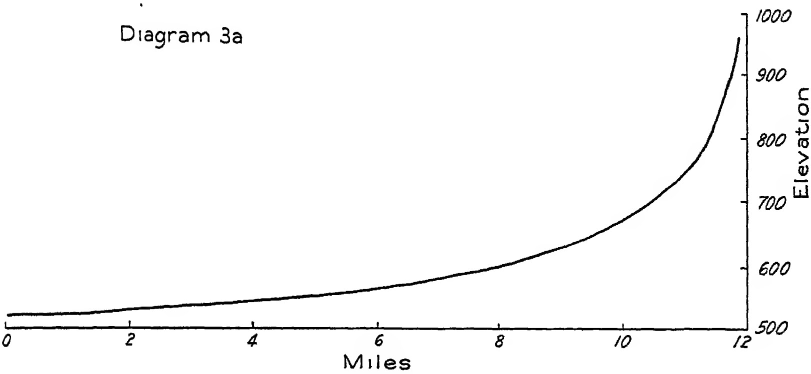


Diagram 3a. Gradient of Ice Creek, Lawrence County.

rise to the surface sculpturing of the uplands. West of the Flushing escarpment or in the Lexington area the valleys were more deeply intrenched and more mature than were those east

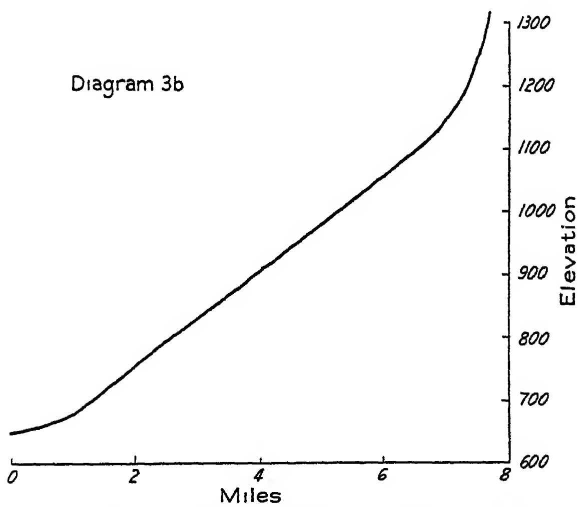


Diagram 3b. Gradient of Pipe Creek, Belmont County.

of this break or in the Harrisburg area. The cause for this is not clear, but appears to be that the area west of the escarpment was in the lower part of a great drainage basin whereas that east of this physiographic line was at the headwaters of streams that

had far to flow before reaching the sea. Further, the nature of the rock was, to some extent, a modifying factor. The soft shale of the Conemaugh series gave way more readily than the fresh-water limestones of the Monongahela or the massive sandstones of the Allegheny and Pottsville.

The difference in stream gradients is quite marked in the two areas. This feature is shown in diagrams 3a and 3b.

The streams in the Lexington area have low gradients along their lower courses with little or no intrenching. The cutting is mainly at the headwaters. Such streams show maturity in the cycle of erosion. The streams in the Harrisburg area, in contrast, have rather high and uniform gradients throughout. Intrenchment is still going on throughout much of their courses.

HARRISBURG LEVEL WEST OF FLUSHING ESCARPMENT

Throughout that part of Ohio south of the drift border and west of the Flushing escarpment the Harrisburg peneplain level is identified by the higher ridge crests throughout much of the area. The common elevation, however, descends considerably below that in the highland area east of the Flushing escarpment. Throughout much of Carroll, Tuscarawas, Holmes, western Harrison, southwestern Ross, western Pike, and eastern Adams counties many ridges reach the 1,260 foot level. In much of Coshocton, Guernsey, Muskingum, Noble, Washington, Morgan, Hocking, and Athens counties they range between 1,100 and 1,260 feet, whereas in Meigs, Gallia, Lawrence, and Scioto counties they seldom exceed 1,100 feet and many are much below this. These ridge crests thus appear to mark the floor of some ancient drainage basin that gave rise to the base leveling and drained southwest into Kentucky.

HIGHLAND AREAS WITHIN THE DRIFT

Other highland areas within the State, but within the field of drift, comparable in elevation (1,260–1,280 feet) to that in eastern Ohio, are found around Loudonville in Morrow, Richland, Ashland, and Knox counties, near Chardon in Geauga, near Zanesfield in Logan and Champaign, and around Chillicothe in Ross. The first mentioned area includes northeastern Morrow, southern Richland, northern Knox, and southwestern Ashland counties. This is really the highland area of Ohio as the general elevation of the ridge crests is higher here than elsewhere in the State. The region is considerably

smoothed by drift. The area around Chardon is relatively small and belongs at the crest of the wall of the Portage escarpment that stretches eastward from Cleveland to Albany, New York. The area in western Ohio in Logan and Champaign counties is capped by Campbell Hill, 1,550 feet, the highest point in the State. It is drift covered. The Zanesfield area includes eastern Logan and, with less definition, eastern Champaign County. In the Chillicothe area the highest ridges are east of the Scioto River in the vicinity of Mount Logan and south of Paint Creek near that of Copperas Mountain. These widely scattered remnants thus show that the 1,260–1,280 foot level was defined across the State.

UPLIFT AND REJUVENATION

Harrisburg peneplanation was brought to a close by uplift and rejuvenation, regional in extent and in influence. This movement was certainly not violent but appears to have been slow and orderly. In Columbiana County the total rise was some 140 feet and in Vinton County not far from 100 feet. After this event another long period of crustal stability gave rise to the second stage of base leveling resulting in the Lexington peneplain.

Lexington Peneplain

GENERAL FEATURES

The Lexington peneplain, also known as the Worthington, received its name from the regularity of the ridge crests in the Bluegrass region near Lexington, Kentucky. In the unglaciated part of Ohio this erosion level is best represented in eastern Scioto, Lawrence, Gallia, Meigs, Jackson, and Vinton counties. During the upwarping the streams with renewed activities soon cut deep valleys in the older surface and during the long period of crustal quiescence that followed they gradually developed wide gradation plains along their courses and also reduced the water divides between many basins to much lower levels.

West of the Flushing escarpment the Lexington level is well defined but east of this it is commonly only a strath stage and in some areas without apparent definition. It appears as shoulders, from 1,100 to 1,160 feet, along Little Beaver and West Fork in Columbiana County, along Short Creek in Jefferson, along Wheeling, McMahon, and Captina creeks in

Belmont, and along Sunfish Creek in Monroe. West of the Flushing escarpment the common crest level along the divides is 930 to 990 feet. This surface is best defined in eastern Scioto, Lawrence, Gallia, Meigs, Jackson, and Vinton counties and is marked to a less extent in eastern Hocking, western Athens, western Morgan, Perry, and central Muskingum counties. The general effect is that of a low flat basin the trough of which slopes in a general way southwestward into Kentucky. Lexington peneplanation is accredited to late Tertiary time.

Certain features warrant the assumption that the high-level surface east of the Flushing escarpment, called Harrisburg, is really the same in age and in origin as the one from 250 to 300 feet lower to the west of the divide, known as Lexington. The two, however, differ not only in elevation but in intensity of sculpturing and in maturity of drainage. Such distinctions may be due to many contributing elements operating under somewhat different conditions. The area east of the Flushing escarpment was drained by a stream flowing eastward to the sea, whereas that west of the divide was drained by one flowing westward to the gulf. These master streams differed in the length of the courses, in the gradient of the floors, in the physiographic provinces traversed, in the nature of the rocks eroded, in the dip of the strata and in other factors of less importance. Such causes may be sufficient to account for the distinctive features of the two areas, truly correlative in age.

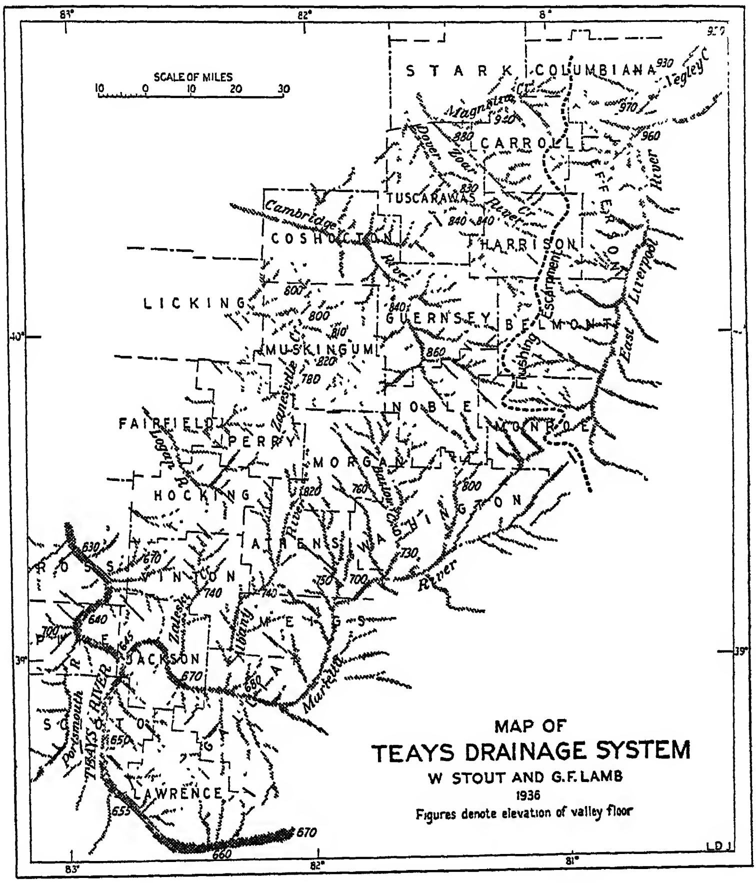
UPLIFT AND REJUVENATION

Again regional uplift prevailed with consequent rejuvenation and with the initiation of another cycle of erosion. In general the floors of the new streams thus formed in the unglaciated part of Ohio were from 150 to 190 feet below the Lexington or 260 to 340 feet below the older Harrisburg peneplain. At the other extreme of the unglaciated area, Scioto County, the floors of the major streams of this cycle of erosion now stand from 640 to 740 feet above tide. This causes them to fall from 190 to 250 feet below the Lexington level here the main peneplain for reference. The latter condition, or interval, is not far different in the other counties west of the Flushing escarpment.

Parker Strath—Teays Drainage Stage

GENERAL STATEMENT

The third well-defined modification of the surface through the work of erosive agencies is the Parker strath which is the name applied collectively to the remnants of old valleys formed



by stream action just prior to the first ice invasion or in late Tertiary time. This general stage of erosion is commonly referred to as Teays because the master stream, as now known, of that period was the Teays which was of wide lateral extent, had important modifying influences, and left many interesting features for future study. The Parker strath may be defined

as an immature peneplain or erosion level, the work of streams during Teays time. (See map of Teays Drainage System.)

WORK DONE DURING TEAYS TIME

This new cycle of erosion was inaugurated by a slow uplifting of the land that brought to a close the long period of quiescence which resulted in the formation of the Lexington peneplain. As a consequence of this upward movement of the surface by internal forces the streams were rejuvenated and began carving valleys in the recently elevated plain. The Parker cycle was short compared to the more remote Lexington and Harrisburg but yet it was of sufficient duration for a large amount of work to be done. The streams of Teays time maturely dissected much of the older gradation surfaces and lowered many of the water divides. In general they cut rather broad valleys with moderate slopes from 150 to 250 feet below the mean level of the Lexington peneplain. The uplifting appears to have been gradual or at least without prolonged pauses as rock cut terraces are not conspicuous at any position on the valley walls. The Parker cycle was brought to a close by the advance of an early ice sheet, probably Jerseyan which caused general modification and rearrangement of the drainage systems of the entire region.

EARLY RECOGNITION OF OLD STREAMS

Drainage modifications are so conspicuous in the unglaciated part of the State, especially the southern portion, that they were noted by most of the geologists that worked in this field. Prominent deserted valleys, sudden changes in soils, peculiar types of clays, beds of gravel and sand, buried wood, rounded stones, etc., were evidences that attracted the attention and led to speculation if not to definite records. The history of drainage changes goes back to the recorded observations of that great scientist and master mind, Dr. S. P. Hildreth, of Marietta. In the First Annual Report of the Geological Survey of Ohio, dated January 17, 1838, he states under the title "Fossil fresh water shells,—Bed of ancient Lake":[1]

"On Mr. Lawton's farm, in Barlow township, Washington County, in the midst of the marl region, is a locality of fossil fresh water shells, of the genus *Unio*. They are imbedded in coarse sand or gravel, cemented by ferruginous matter. The

[1]First Annual Report, Geological Survey of Ohio, 1838, p. 50.

specimens are casts, replaced by an argillaceous oxide of iron. The spot in which they are found, has once evidently been the bed of an ancient lake or pond. It is now a beautiful valley of a mile or more in width, by four miles in length, surrounded by low hills. On the south side, a small branch drains the superfluous water into the Little Hocking. In digging wells for domestic use, in this tract, beds of sand, gravel and plastic clay, are passed to the depth of 30 feet, containing imbedded branches of trees, leaves and fragments of wood, of recent and living species. Similar valleys and levels are found in the uplands of the western part of the county, lying between the head waters of the creeks, and are a kind of table land. From the frequency of these flat lands between the head waters of the Little Hocking and the south branch of Wolf creek, it is quite possible that, at some remote period, the waters of Wolf creek were discharged into the Ohio river instead of the Muskingum. This opinion is strengthened from the fact, that the head branches of the south fork now rise within two miles of the Ohio, and run northerly, parallel with and opposite to, the course of the Muskingum for 12 miles, and joins that river, 20 miles from its mouth. The remains of its ancient beds would form pools and ponds of standing water, furnishing fit residences for the fresh water shells, whose fossil remains are now found there. Great changes have, evidently, been made in the direction of all our water courses, before they found their present levels."

The old stream here described, was of Teays time, rose in the upper reaches of what is now the Meigs Creek basin, flowed southward past Waterford, Watertown and Barlow to the old Marietta River at the village of Little Hocking, on the Ohio.

The geologists contributing to the survey of Ohio in 1869 and 1870 made a few comments but no lengthy discussions on drainage changes. Read, however, in 1878, describes with considerable detail the ancient river systems in Knox County and Orton, in the same year, traces the old streams connecting the valleys of the two Miamis in Warren County. The drainage of western Pennsylvania became of interest between 1890 and 1900 when Foshey, Hice, Chamberlin, and Leverett began to trace the old water ways with much care. Tight in 1897 began serious work on the old drainage systems in central Ohio and in 1903 wrote his masterpiece on the Teays in southern Ohio and adjacent parts of West Virginia and Kentucky. Other

workers of this time were Bownocker, Todd, Fowke, Clark, and Davis. Since 1900 considerable work has been done on local modifications or on special phases of ancient drainage by Campbell, Lamb, Scheffel, Hubbard, Hyde, Conrey, Stout, Coffey, Lamborn, Ver Steeg, White, Scranton, Sharp, Cole, Happ, and others.

TEAYS RIVER

The master stream, the Teays River, rose far out in the Piedmont of North Carolina and Virginia, flowed northwestward to Charleston, West Virginia, thence westward along the route now followed by the Chesapeake and Ohio Railway past St. Albans, Milton, and Barboursville to the present valley of the Ohio River at Huntington. From this place its course was much the same as that of the present stream, the Ohio River, to Wheelersburg, Ohio, where the two courses change radically. From Huntington to Wheelersburg, however, the old Teays floor is well recognized by wide flats south of Ashland, Kentucky, and by prominent terraces between Franklin Furnace and Wheelersburg on the Ohio side. From Wheelersburg the present stream flows westward towards Portsmouth and Cincinnati, whereas the preglacial Teays River continued northward past Minford, Stockdale, Glade, Beaver, Givens, Waverly, Richmondale, and Vigo to Chillicothe, beyond which the old valley is buried with a thick mantle of glacial drift. From Chillicothe, however, the course is traced with some certainty to near Circleville where, from work of Ver Steeg, the stream turned and then flowed northwestward past the St. Marys Reservoir, finally ending in the Gulf then extended far northward.

The rock floor of the old Teays River as determined has an elevation of about 670 feet at Scary, West Virginia, 660 feet at Huntington, 650 feet at Russell, Kentucky, 650 feet on Dogwood Ridge near Wheelersburg, Ohio, 640 feet at Glade, 640 feet at Waverly, and 630 at Chillicothe, beyond which the floor is deeply buried by drift. For this distance the gradient of the old floor is low, only about 4 inches per mile. The stream was thus quite mature and had reached its maximum depth of cutting.

The width of the valley proper varies from 1 to 2 miles but averages not far from 1.45 miles. In general from Huntington, West Virginia, to Chillicothe, Ohio, the width is

rather uniform, widening somewhat down stream through the influence of various tributaries, some of fair size. Throughout this part of the course the depth of cutting or the relief at that period was about 300 feet. This is the difference between the floor level of the Teays River at 630 to 660 feet and that of the ridge summits of the Lexington peneplain at 930 to 960 feet. Such differences, however, decreases as the tributary streams, as the Marietta, Portsmouth, Albany, Zaleski, etc., are followed headward.

In general the hills bordering the Teays River and its larger tributaries are low and well rounded, the resultant of prolonged, rather mature erosion. Their height and shape, however, are influenced by the nature of the rocks composing them. Where shales predominate the relief is much more gentle than where sandstones are the dominating strata. Within the entire Teays basin in Ohio south of the drift border the streams have maturely dissected the uplands. The pattern is decidedly dendritic, even to the small runs and rills at the headwaters. The floor gradients also show an advanced stage in the erosion cycle.

The old Teays Valley is well preserved and open for study in many places along its course. In West Virginia the outstanding examples are along the route of the Chesapeake and Ohio Railway from St. Albans to Barboursville and the wide flats southeast of Huntington. In Kentucky the floor with its characteristic silts is well defined south of Ashland and Russel. In Ohio the course of the Teays River is clearly marked all the way from Wheelersburg in Scioto County to Chillicothe in Ross. From the Sun Hill near Wheelersburg one may gaze eastward across the Teays Valley, northward down the course of this ancient stream, southward into the valley of the Ohio, with the Deep Stage buried by about 100 feet of silt, sand, and gravel, and westward to the col between the Teays and Portsmouth rivers. The village of Minford in northern Harrison Township, Scioto County, is the type locality for Minford silt, here so well exposed in the cut of the Chesapeake and Ohio Railway. The old valley with only minor modifications is well defined northward from Minford past Stockdale to Glade where it was joined by the Marietta River. From Glade westward past Beaver and Givens to the Scioto River both the Teays and the present drainage forms interesting studies. Northeast of Waverly the Teays and present drainage parallels

one another, the streams flowing in the opposite directions. From Richmondale northward to Vigo, to Londonderry, and on to Chillicothe the old valley is much modified by deposits from the Illinoian and Wisconsin drift.

MINFORD SILT

Throughout southern Ohio and in adjacent parts of West Virginia and Kentucky, the preglacial drainage lines are all much choked with highly laminated silt, fine sand, and, very locally, coarse rubble. Such materials are found not only along the main waterways of the Teays drainage systems, but also far up the smaller tributaries. The deposits on the old floors are best preserved in the parts of these valleys that do now form divides between present streams and in the parts that were abandoned through piracy, meanders, and other adjustments.

The outstanding deposits in these old valleys are the plastic, highly laminated silts which are well distributed throughout the entire basin, being present locally on the small tributaries as well as on the main stream. The thickness of such deposits varies from 10 to possibly more than 80 feet, but usually the measurements range from 20 to 40 feet.

These silts, called Minford from exposures near that village, are always highly laminated, the laminae being closely and regularly spaced. The material is extremely fine in grain, has a sticky plasticity with little dry strength and has a smooth feel, either wet or dry. The unoxidized color is dark bluish gray and the weathered is brownish gray to drab shades.

The following analyses are representative:

Analyst—Downs Schaaf.

	No. 1	*No. 2*	*No. 3*	*No. 4*
Silica, SiO_2	55.91	50.02	53.40	57.35
Alumina, Al_2O_3	17.30	23.10	28.08	24.16
Ferric oxide, Fe_2O_3	8.58	7.08	4.50	5.25
Ferrous oxide, FeO	1.33	1.16	.....	.....
Titanic oxide, TiO_2	1.00	.74	.75	.80
Phosphorous pentoxide, P_2O5	.18	.75	.10	.11
Manganous oxide, MnO	.06	.05	.02	.03
Calcium oxide, CaO	.90	.86	.66	.48
Magnesium oxide, MgO	2.41	2.80	1.94	1.46
Potassium oxide, K_2O	3.25	4.40	4.40	4.84
Sodium oxide, Na_2O	.45	3.43	trace	.10
Sulphur, S	.04	.015	.....	.....

Water, hydroscopic, H_2O-	2.52	2.77	5.13	5.10
Water combined, H_2O+	5.27	3.23		
Carbon, organic, C	.25	.05	.50	.10
Carbon dioxide, CO_2	.72	.04	.30	none

No. 1. Sample taken by R. E. Lamborn, 1929, at cut at Minford, south central Section 33, Madison Township, Scioto County.

No. 2. Sample taken by W. Stout and Downs Schaaf, 1928. Sample taken mainly from upper layer at same locality.

No. 3. Sample taken by W. Stout and Downs Schaaf, 1928, east central Section 25, Union Township, Pike County.

No. 4. Sample taken by W. Stout and Downs Schaaf, 1928, northeast quarter Section 18, Seal Township, Pike County.

The Minford silts are characterized by fineness and uniformity of grain, by high plasticity, by closely spaced laminations, by high content of sericitic mica and by a consistency of character throughout a wide area. They were deposited in rather deep and comparatively quiet waters which were ponded to lake-like conditions throughout the valleys had slight motion and stood well towards the rims of the basins. The high content of sericitic mica indicates that the Minford silts were derived largely from the schists of the Piedmont and therefore the streams headed well out on this old highland. Through obliteration of the lower courses of the Teays streams by glacial action and through flooding of the remaining parts of the courses new drainage lines were established simply by the ponded waters pouring over low divides and cols, thus seeking new ways for outlet to the sea. The new streams, known as Deep Stage drainage, flowed undisturbed until they cut youthful valleys much below the former, or Teays, drainage level.

TRIBUTARIES OF TEAYS

In southern Ohio the master stream of the Teays system was joined by a number of tributaries a few of which were of fair size. The largest of these was the Marietta River, a stream that gathered its headwaters near Marietta, flowed southwestward past Parkersburg, West Virginia, Little Hocking, Coolville, Tuppers Plains and Chester, Ohio, to Hartford, West Virginia, thence across Mason County in that state to Cheshire, Ohio, thence southwestward along the present valley of the Ohio to near Gallipolis where its course was deflected northwestward past Rodney, Rio Grande, Centerville, Clay, Camba,

Keystone, Jackson and Cove to Glade, there joining the Teays River. Some of the larger tributaries of the Marietta were the Albany River, Zaleski Creek, and Barlow Creek.

PORTSMOUTH RIVER

The Portsmouth River rose near Manchester in Adams County, flowed eastward along what is now the valley of the Ohio past Rome and Buena Vista to Portsmouth, thence northward past Lucasville, Wakefield and Piketon to near Waverly where it united with the Teays. Remnants of the old Portsmouth Valley, not greatly disturbed, are found east of Lucasville, east of Clifford, at the mouth of Camp Creek, east of Wakefield and east of Piketon. In fact, from Portsmouth to Piketon the present Scioto occupies no large part of the old Portsmouth Valley.

LOGAN RIVER

The Logan River, a stream of Teays time, headed near the Athens-Hocking County line on the present Hocking River, flowed northward past Haydenville, Logan and Lancaster to either a large tributary or to the main stream of the Teays River. Old floor levels with Minford silts are present in many places near Union Furnace, Logan, Haydenville, Webb Summit and Greendale. The northern portion of the valley is filled with outwash and glacial drift.

PUTNAM CREEK

In Muskingum, eastern Licking and northeastern Perry counties remnants of drainage of Teays time are quite distinct in local areas. This stream may be called Putnam Creek as the old floor is so well preserved west of this place. It gathered its headwaters south of Crooksville in northeastern Perry County, flowed northward past Roseville, South Zanesville and Putnam to Shannon, thence westward to Newark where the old floor is lost in drift. A tributary of this stream rose near the Morgan-Muskingum County line, flowed northward past Philo to Sonora, thence westward joining Putnam Creek a few miles north of Zanesville. Remnants of old floors are well defined near Chandlersville, Sonora, Gilbert and Shannon. Typical Minford Silts are present near Roseville, Moxahala, South Zanesville, and Putnam, indicating that this stream was a direct tributary to the Teays. The elevation of the floor of Putnam Creek is

not far from 780 feet at Moxahala, 770 feet at Putnam, and 760 feet at Shannon, and that of the tributary 780 feet at Carlwick and 770 feet near Sonora. Along the course of this stream the bordering hills are commonly low and well rounded, a maturity indicative of that of the Teays.

CAMBRIDGE RIVER

The headwaters of the Cambridge River, the old stream of Teays time, was the same as that now drained by Wills Creek. It rose just west of the Flushing escarpment and had maturely dissected the area. Its course was northwestward past Cambridge, Kimbolton, Birds Run and Plainfield to West Lafayette where it entered the great valley now occupied by the Tuscarawas. From West Lafayette the course of the Cambridge River is not so definite as there is little evidence in support of either route. The main trend would project it past Coshocton and Warsaw to Millwood beyond which the bed is deeply buried by drift. Such a course would place a col on the Muskingum River near Adams Mills and another on the Tuscarawas near Gnadenhutten. Remnants of old floors are seen near Cambridge at an elevation of 840 feet, near Plainfield at 800 feet, and near Coshocton at 780 feet.

DOVER RIVER

One of the important early streams of southeastern Ohio was what may be called the Dover River which with tributaries drained parts of Belmont, Guernsey, Harrison, Tuscarawas, Holmes, Carroll, Columbiana, and Stark counties. These streams gathered their waters north and west of the Flushing escarpment in an area the general topography of which is much like that in the Teays basin. The Dover River headed far south, less than twenty miles from the Ohio River, in northwestern Belmont, northeastern Guernsey and western Harrison counties, in an area now drained by Stillwater Creek. The ancient stream flowed northward past Freeport, Uhrichsville, Dover and Beach City to Navarre where a thick mantle of drift leads to obscurity. The Dover River was joined by eastern tributaries, one in the valley now occupied by Conotton Creek and another in that of Sugar Creek. Owing to deep filling of drift and outwash and to obliteration by the succeeding stages of drainage, remnants of the floor of the Dover River are not conspicuous. The few observations such as at Newport

and Magnolia indicate that the main streams stood at elevations between 860 and 900 feet. The evidence is in support of the Dover River flowing on northward into the Lake Erie basin.

PITTSBURGH RIVER

The course of the Pittsburgh River has been carefully traced by Foshay, Hice, Leverett, Chamberlin, Campbell, Lamb and others throughout its extent south of the drift border. The main stream gathered its headwaters in the basins now occupied by the Allegheny and Monongahela rivers and flowed northwestward from Pittsburgh to Beaver, thence northward past Beaver Falls and New Castle to Hubbard, thence westward to Youngstown, and thence northward where it soon becomes lost under a deep mantle of drift. Evidence now available indicates that it flowed on northward through the Grand River basin to Lake Erie.

STEUBENVILLE RIVER

In Ohio, aside from the lower course of the main stream, the chief interest is a tributary that rose just east of the Flushing escarpment near Hannibal in Monroe County, flowed northeastward past Clarington, Bellaire, Steubenville and East Liverpool to Beaver, Pennsylvania, where it united with the main stream of the Pittsburgh River. This tributary, here called the Steubenville River for the sake of definition, drained parts of Monroe, Belmont, Harrison, Carroll and Columbiana counties and all of Jefferson. Another small tributary, disdinctively named Negley Creek, drained most of Columbiana County. The Steubenville River and Negley Creek thus received the waters from the highland area of southeastern Ohio, the western border of which is the Flushing escarpment.

Along the upper course of the Steubenville River little evidence remains of old floors as the main stream and its tributaries had dissected little below the level of the Lexington peneplain, here only a strath stage. Further, through succeeding stages of cutting the streams simply dug themselves deeper in the same courses, thus obliterating the early prints, that of Teays time. Some shoulders, terraces and floors assigned to this stage appear at 1005 feet at Wellsburg, 990 feet at Costonia, 985 feet at New Cumberland, and 960 feet near Wellsville and East Liverpool. Along Negley Creek the evidence is more conclusive as the old floor is distinct in many

places. Near West Point the floor of the broad upland valley has an elevation not far from 970 feet and at Negley close to 930 feet. The Pittsburgh River thus draining the highland area of southeastern Ohio was a system separate and distinct from the Teays. The former evidently discharged its waters eastward to the Atlantic Ocean and the latter carried its load westward through the interior basin to the Gulf of Mexico.

EFFECTS OF AN EARLY GLACIER

The evidence supporting an early drift sheet, possibly Jerseyan, that touched Ohio, is more from effects on drainage than from direct deposits left from such an ice invasion. So far no deposits certainly attributed to this early ice flow are known in the state. Many changes, especially drainage modifications, are apparent in wide areas, are sufficiently old in point of physiographic history and are difficult to account for on any other assumption than the effects of an early glacier. Deposits assigned to the Jerseyan, or to a sheet much older than the Illinoian, are present in New Jersey, in east central Pennsylvania and locally in northwestern Pennsylvania.[1] Such deposits are considered correlative with strata of an early sheet in the Mississippi Valley.

In Ohio this early drift sheet appears to have not seriously modified any of the streams, such as the Pittsburgh, and Dover rivers flowing northward to the Lake region, but to have completely blocked the western course of the Teays. The eastern streams in passing from Teays to Deep Stage time simply settled down deeper in their course with only slight modifications.

The Teays River, however, was completely dammed in its lower course, with the result of flooding in the main valley and in those of all the larger tributaries. This was especially true of the streams in southern Ohio. Such valleys became long finger lakes. It was during this time that the Minford silts were deposited from the fine materials long held in suspension and carried into the basin from headwater areas, some far out into the Piedmont Plateau. Such silts in southern Ohio are found at elevations as high as 840 feet and are thus plastered well up on the valley walls of these old streams the relief of which was from 250 to 300 feet, the usual position below the Lexington peneplain. Eventually through continued ponding

[1] Leverett, Frank. Glacial Deposits in Pennsylvania. *Pennsylvania Topographic and Geologic Survey*, Bulletin G 7, 1934.

the waters broke over low divides or cols and soon established a new system of drainage bearing little resemblance in direction or pattern to the older Teays system. This second cycle of drainage is known as the Deep Stage on account of the depth of cutting of the valleys.

UPLIFT AND REJUVENATION

Soon after the new system of drainage was outlined regional uplift took place with consequent active cutting of stream beds. Through this the stream floors were degraded much below the level of the Teays. At Wheelersburg where the Teays and Cincinnati rivers, both major streams, were in contact, the difference is 190 feet, the floor of the former standing at 650 feet, and that of the latter at 460 feet. This uplift, regional in extent, took place rather rapidly as the streams cut deep narrow valleys, a feature characteristic of this cycle of erosion. Compared to Teays the time interval of the Cincinnati cycle of erosion was not long as the streams of the latter were unable to widen the valleys, to deepen them headward, or to lower the bordering hills. During the period, however, much work was done as the major streams cut deep narrow valleys through thick deposits of resistant rock.

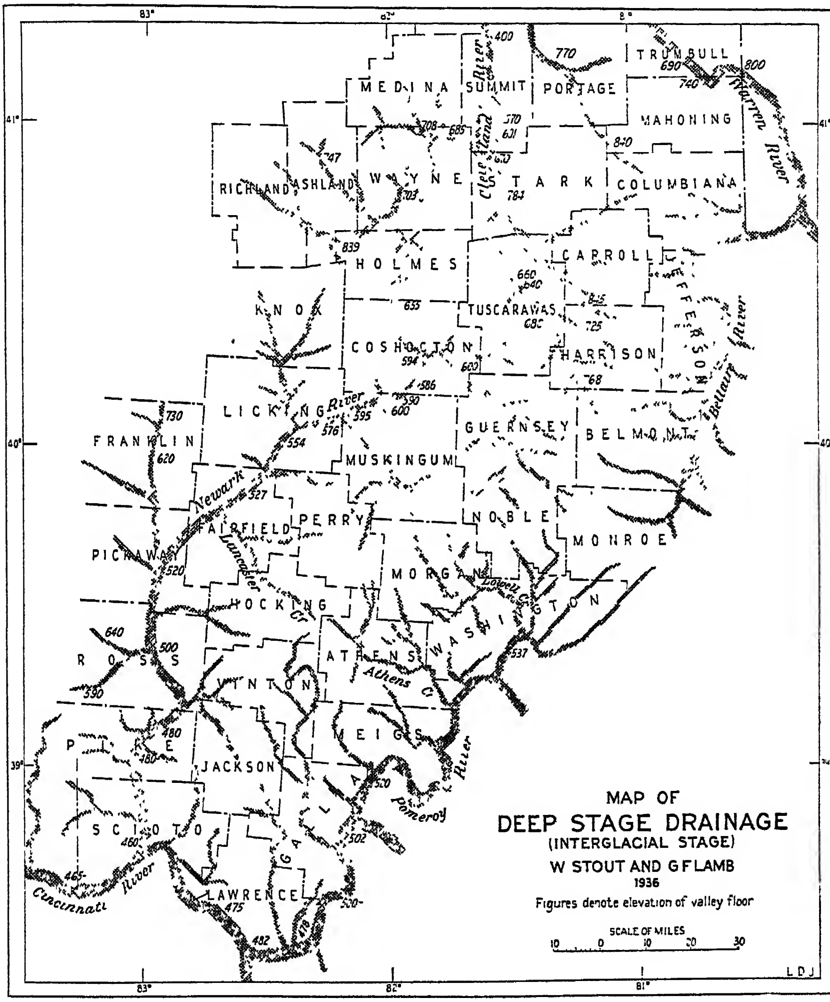
DEEP STAGE DRAINAGE

The Deep Stage drainage was first defined by Coffey and later detailed in parts by Ver Steeg, Lamborn, Lamb, Scranton, Happ, White and others. This cycle of erosion is interglacial in that it was inaugurated by an early ice sheet, possibly Jerseyan, and brought to a close by the Illinoian. Its main features are the development of many new streams especially in the old Teays basin, the deepening of all channels below the former levels, and the general immaturity of basin reduction. The important streams of Deep Stage time that drained southern Ohio are next considered. (See map of Deep Stage Drainage.)

CINCINNATI RIVER

The master stream of the area, which for clearness may be called the Cincinnati, received its waters almost entirely from the basin formerly drained by the Teays. This area includes that within the present basins of New, Gauley, Little Kanawha, Kanawha, Big Sandy, Little Sandy and others in southwestern Virginia, West Virginia, and eastern Kentucky,

and within those of the Muskingum, Hocking, and Scioto rivers in Ohio. The headwaters of the Cincinnati River need not be discussed here. From Charleston, West Virginia, the course was not along that of the Teays but along that of the



present Kanawha to Point Pleasant. Here the new stream turned southwestward following within the basin but not along the direct course of the older Marietta River to Gallipolis, thence across a divide into the old Teays valley again at Huntington. From Point Pleasant to Huntington this is the

route of the present Ohio. From the latter place the Cincinnati River turned northwestward and closely followed the course of the Teays to Wheelersburg, thence across a divide to the old Portsmouth River, thence across another divide into an old basin of Teays time. Thus from Huntington the course was that of the present Ohio past Ironton, Portsmouth, Manchester and Maysville to Cincinnati, and thence on westward to the interior basin, where it finally discharged its waters into the Gulf of Mexico. The floor of the Cincinnati has an approximate elevation of 360 feet at Cincinnati, 460 feet at Portsmouth, 480 feet at Kenova, and 490 feet at Point Pleasant.

NEWARK RIVER

The Newark River as defined by Lamborn and other workers was an important tributary of the Cincinnati River and drained a large area in central and south central Ohio. This stream gathered its headwaters in part in the basin of the old Cambridge River and along that portion of the present Tuscarawas to the old divide at Gnadenhutten, which barrier separated the north-flowing from the west-flowing streams. Near Coshocton the Newark River received an important tributary from the north the basin of which is now drained by Killbuck Creek and the Walhonding River. The main stream thus formed by such contributions then flowed southwestward to Conesville, thence westward along the present Muskingum to Trinway, thence westward through the conspicuous abandoned valley past Frazeysburg and Black Run to Newark where the course is less evident through deep burial by glacial drift. As shown by Lamborn, the main stream received at Newark an important tributary from the north, then flowed southwestward past Buckeye Lake, Basil and Carroll to Circleville where other tributaries were received from the north. From Circleville the course of the Newark River was southward, along the present Scioto, past Chillicothe, Richmondale, Waverly and Piketon to Portsmouth, where it joined the master stream, the Cincinnati River. From Chillicothe to Waverly the Newark River flowed in reverse direction to the Teays and from Waverly to Portsmouth in reverse to that of the Portsmouth. The floor of the Newark River has an elevation of approximately 480 feet at Waverly, 500 feet at Chillicothe, 520 feet at Circleville, 521 feet at North Baltimore, 541 feet at Buckeye Lake, 554 feet at Conesville and 594 feet at Coshocton.

The Newark River had many small tributaries, a few of which may be mentioned. One began near the Morgan-Muskingum County line, flowed northward past Philo, Zanesville and Dresden to the main stream at Trinway. Another branch of some importance began at the divide near Nelsonville, flowed northward past Haydenville, Logan, and Lancaster, and united just north of Carroll with the Newark River. The course of another Deep Stage stream is quite apparent from South Bloomingville westward to Laurelville. Important tributaries, now deeply buried by drift, were received from the north at Circleville and from the west at Chillicothe. The Newark River and its tributaries are responsible for much physiographic history of interest in central and southern Ohio.

POMEROY RIVER

A stream of Deep Stage time of importance in southern Ohio is what may be called the Pomeroy River from the name of the place in Meigs County past which it flowed. This stream gathered its headwaters west of the Flushing escarpment in the Lexington peneplain area in southern Monroe, southern Noble, and eastern Washington counties. It flowed within the basin of the Marietta River of Teays time but instead of following closely the older course it carved a new way well up on the rim of the depression. The course was that now taken by the present Ohio from Marietta past Parkersburg, Ravenswood, Racine and Pomeroy to Point Pleasant where it united with the Cincinnati River. Tributary divides were near Sardis on the present Ohio River, at the Morgan-Muskingum county line of the Muskingum River, and at the Athens-Hocking county line on the Hocking River.

CLEVELAND RIVER

The Deep Stage Cleveland River drained, in the main, the basin of the Teays Stage Dover River. In the headwater areas little change was made during the second cycle except deepening the channels some 200 feet below the former level. These streams were deeply entrenched, had steep abrupt walls, and were immature in gradation and dissection. The major stream has been well traced by Ver Steeg and others northward from Uhrichsville past Dover, Massillon and Barberton to Lake Erie at East Cleveland. It gathered its headwaters, north and west of the Flushing escarpment, in

northwest Belmont, northeast Guernsey, western Harrison and southeast Tuscarawas counties in territory reduced mainly to the level of the Lexington peneplain but within the basin of the north-flowing streams. The Cleveland River shows abnormalities in character of gradient, depth of channel, and character of fill.

WARREN RIVER

The Deep Stage cycle of stream development in eastern Ohio and western Pennsylvania consisted, in the main, of simply deepening the courses of the older Teays cycle as the limits of the basins and as the general direction of the courses remained much the same in both. Only minor changes are evident. Throughout the entire area the streams still have Deep Stage characteristics: that is, they have narrow valleys with steep walls, have few laterals, and have not prominently reduced the bordering hills.

The main stream was what may be known as the Warren River. Its course was quite the same as that of the Pittsburgh River, that is northward from Pittsburgh, past Beaver Falls, New Castle, Hubbard and Youngstown to Warren where it is deeply buried by drift. From Warren the stream appears to have flowed on northward to Lake Erie. The tributary receiving drainage from southeastern Ohio for identification is called the Bellaire River. Throughout this area the Teays and Deep Stage cycles of erosion were continuous or without a definite break, the definition coming from changes and influences at work elsewhere.

ILLINOIAN GLACIATION

GENERAL STATEMENT

One of the important factors in changing the physiography of Ohio was the Illinoian glacier which had a marked influence in leveling the surface, through burial by drift, of about three-fifths of the state and further in changing the drainage systems throughout the entire area. The position of the Illinoian ice front in northeastern Ohio is not known as the later Wisconsin drift pushed farther south and thus obliterated the evidence of the preceding sheet. The Illinoian drift is first evident near Loudonville in Ashland County. From here the border of this drift extends southward past Brinkhaven, Knox County; New Guilford, Coshocton County; Hanover, Licking County; Gratiot,

Muskingum County; Fultonham and Junction City, Perry County; Sugar Grove, Fairfield County; Haynes, Hocking County; Chillicothe and Bainbridge, Ross County; Cynthiana, Pike County; Belfast, Highland County; Seaman, Adams County, to the Ohio River at Ripley, Brown County.

The Illinoian was a thick sheet of glacial ice and hence had much influence both directly and indirectly in shaping surface features. It completely obliterated the Deep Stage drainage in the area passed over and was effective in revamping much of that in a wide area south of its border. It also left great quantities of glacial debris—drift, outwash, etc.—for weathering agencies and stream forces to work upon. This condition was much different from that in pre-Illinoian time where the mantle was only decayed rock and the stream burden only the wash from the hills. South and east of the glacial border the chief work caused through the Illinoian drift was stream modification.

Post-Illinoian Drainage Stage

GENERAL STATEMENT

The answer to the question of whether or not the Illinoian glacier blocked the northward passage of the Cleveland and Warren rivers is uncertain. The chief evidence, however, supports the view that these streams continued undisturbed during the time between the Illinoian and the Wisconsin ice sheets. The older glacier certainly obliterated by burying with a thick mantle of drift the Newark drainage of central Ohio from Hanover to Chillicothe and the Cincinnati River from Ripley to Cincinnati. As this ice was an effective barrier the waters from the unglaciated portion of southeastern Ohio and from large areas in the states to the south sought other outlets and thus established new lines of drainage. (See map of Post-Illinoian Drainage.)

NEW MARTINSVILLE RIVER

In this area the master stream of the post-Illinoian and pre-Wisconsin period, which for definition may be called the New Martinsville River from a place near the col, occupied much the same valley as that of the Ohio of today except that the older stream was reversed in flow. The ice barrier at Ripley completely obstructed drainage to the westward.

Further, no passage ways are evident south of the drift border in the uplands of Kentucky. The ice obstruction resulted in vast ponding of water east of the ice front in all the valleys of the Deep Stage streams. New outlets were a natural consequence. Eventually the flood waters rose to such a height that they found an opening through a low divide or col near Sardis then continued down the Steubenville and Warren rivers and finally reached the sea to the east. This change was affected apparently with no great amount of work. Some cutting was necessary through the highlands at the Sardis col and through the upper course of the Steubenville River. Along many of the older valleys, however, filling took place as the floors of the new rivers were much above the level of the preceding Deep Stage streams. Through these changes the New Martinsville River thus received the drainage of southeastern Ohio, northeastern Kentucky, central and western West Virginia and parts of western Virginia.

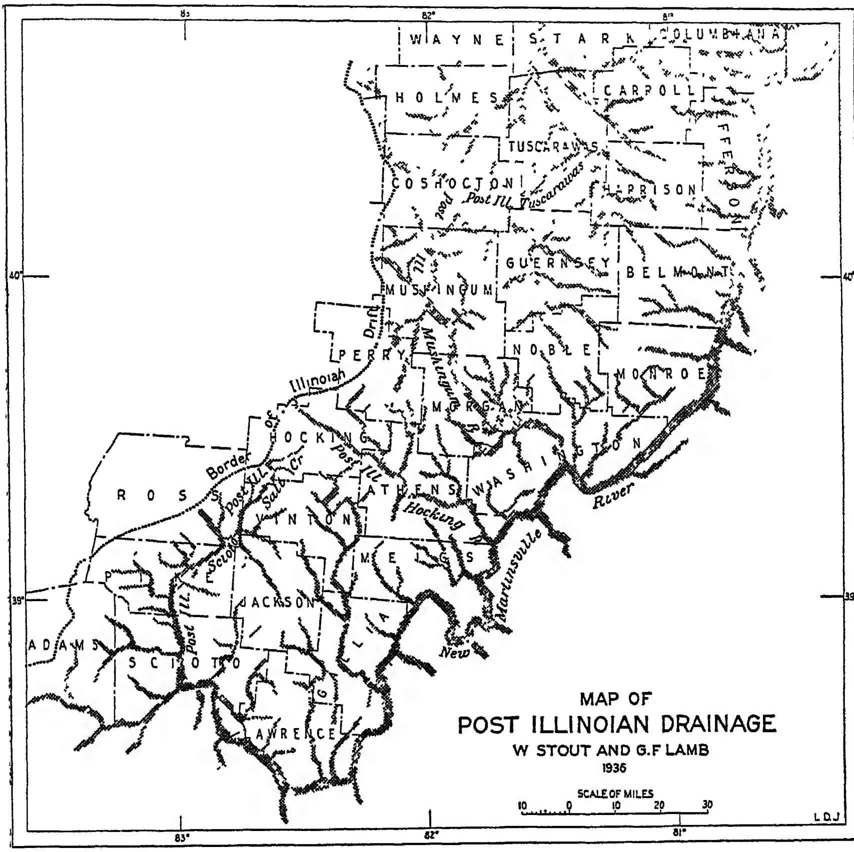
POST-ILLINOIAN MUSKINGUM RIVER

The Illinoian ice sheet at this time thus gave rise to the shaping of the present Muskingum and Hocking rivers by forcing the flood waters over low divides from one basin to another. The Newark drainage system from Hanover to Chillicothe was completely buried by the ice. This obstruction so ponded the headwaters of the Newark River that a new way was opened across the col at the Morgan-Muskingum county line, thus uniting in one stream the old north-flowing river and the south-flowing river. The result of this change was the post-Illinoian Muskingum River which, with some modifications through the later Wisconsin drift period, has remained to the present time.

The ice dam at Sugar Grove caused a discharge of the waters of the small basin of Lancaster Creek over a low divide near the Athens-Hocking county line, close to East Clayton, and then down the Deep Stage Athens River to the major stream, now flowing eastward. Here also little new work was required to make the change as the dividing ridge was low and narrow, as the older streams were deeply trenched well toward their headwaters and as the floor of the new stream was raised, through filling with silt, sand and gravel, to a level much above that of the older one. This post-Illinoian Hocking River thus created has undergone no radical changes since that time. The later Wisconsin cycle of glaciation and erosion made some modifications, mainly through filling.

POST-ILLINOIAN SCIOTO RIVER

The part of the Deep Stage Newark River from Chillicothe to Portsmouth was not materially changed in course during Illinoian time. The work consisted mainly in filling the valley quite deeply with outwash material and thereby raising the floor level. Some side streams, however, were considerably



modified. Salt Creek in Western Hocking and western Vinton counties was shaped at this time. The ice dam at Haynes deflected the waters of several small streams over a col in Section 36, Salt Creek Township, Hocking County to a stream draining to the wouthwestward. At this time local changes were effected in the lower course at Salt Creek. Brush Creek in central Adams County was altered at this time in parts of its course.

Wisconsin Glaciation

GENERAL STATEMENT

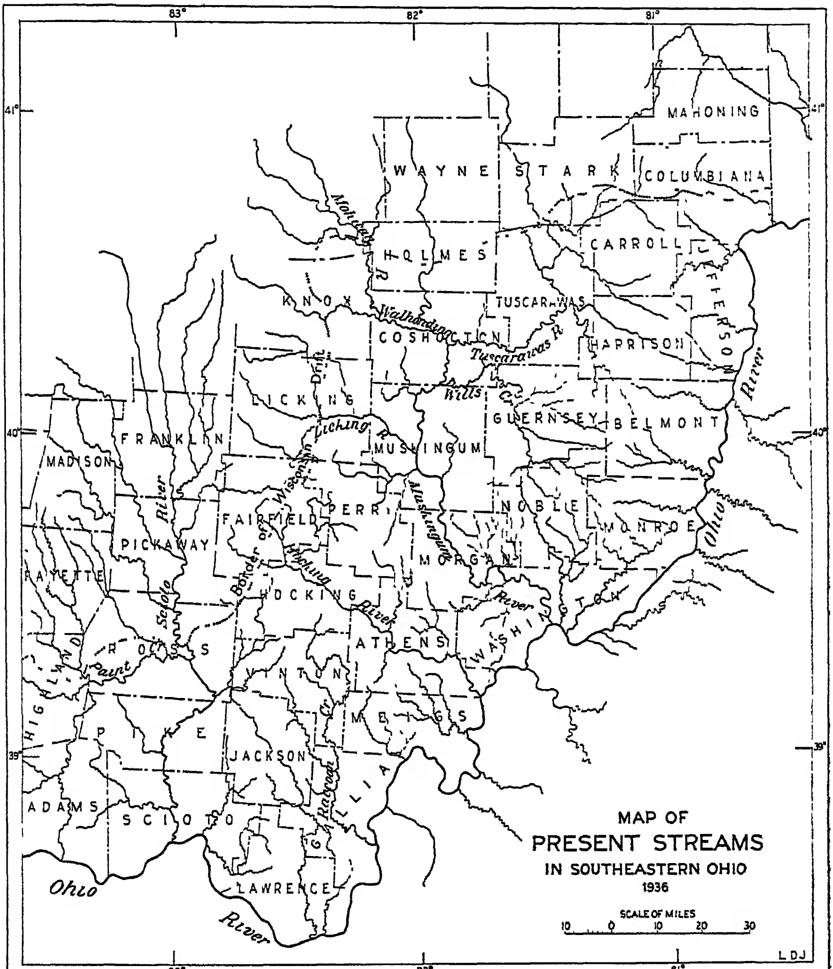
The last great ice sheet to invade Ohio was the Wisconsin glacier, the deposits of which are apparent over about two-thirds of the state. It made many changes in the surface features, leveling certain areas to a smooth plain, piling up drift in others to knobby hills, and filling certain valleys with great quantities of outwash materials. In eastern Ohio the Wisconsin ice sheet extended about one-third of the way across the state, whereas the older Illinoian is considered to be absent or as yet is not definitely recognized. Throughout the central part of the state the two borders are not widely separated, the younger lagging a little behind the older. In western Ohio the conditions are quite different. Here the Illinoian passed south of the Ohio River, whereas the Wisconsin lacked from 15 to 40 miles of reaching this line of drainage. The border of the Wisconsin ice is defined, in a general way, by a line from Clarkson, Columbiana County, westward through North Industry, Stark County; Wilmot, Tuscarawas County; Millersburg, Holmes County; Loudonville, Ashland County, to near Lexington, Richland County. At the latter place the terminal boundary turns southward, through nearly a 90° angle, and extends through Gambier, Knox County, to Chillicothe, Ross County. Another change in direction here deflects the border westward through Rainsboro, Highland County; Martinsville, Clinton County; Hamilton, Warren County, and Lockland, Hamilton County, to the Ohio-Indiana line near the village of Harrison.

The Wisconsin appears to have been a somewhat thicker or more massive ice sheet than the older Illinoian as is indicated by the accumulations left in typical areas. It was certainly an effective barrier in blocking drainage along its front, produced large floods of water for stream work, and yielded great quantities of silt, sand and gravel for outwash deposits along streams that lead out from the border. Beyond the ice border the period was more constructive in building up new deposits than destructive in tearing down old ones. Many changes were thus effected both through the direct action of the glacier in the area passed over and through its secondary modifications far out into the driftless region. Drainage alterations were important.

Present Streams

GENERAL STATEMENT

The chief effects of the Wisconsin glacier on the streams of the driftless area of southern Ohio and of adjacent parts of



the bordering states were, first, changes of direction of flow through blocking some of the older lines of drainage and through the opening of other passages and, second, choking the adjacent valleys with silt, sand and gravel, thus causing the new streams to flow at higher levels. The courses of the present streams

in southeastern Ohio are on this account more or less composite in make-up, some much so. Work may have been done through Teays, Deep Stage, post-Illinoian or post-Wisconsin time or through most any combination of these. The Ohio Valley for example is the result of some action throughout each of these degradation periods. (See map of present streams.)

OHIO RIVER

The ice advanced southward to the middle of the state in western Pennsylvania and to a line through central Columbiana, southern Stark, northern Tuscarawas, central Holmes, southern Ashland and southern Richland counties in Eastern Ohio. It thus completely obliterated the northern passages of the old Warren and Cleveland rivers, making necessary changes in the headwater drainage. The waters from the basin of the Warren River in Pennsylvania and West Virginia and that from the New Martinsville River—draining through the Warren—in southern Ohio, West Virginia and eastern Kentucky were thus forced by the ice dam near Ellwood City, Pennsylvania, to find a new way to the sea. As the Wisconsin glacier did not reach in southwestern Ohio, the old valley of the Deep Stage Cincinnati River with its thin veneer of Illinoian drift, this outlet was reopened and the Ohio River as we know it today took outline with the flow of water to the west. Much of the work involved in this change was simply filling and regrading.

TUSCARAWAS RIVER

Burial of the lower part of the basin of the old Cleveland River by the Wisconsin glacier with stagnation of the headwaters appears to be the most plausible explanation for the peculiar shifts of the present Tuscarawas River from Bolivar to Coshocton. Through ice advancement the waters from the Sandy Creek basin were deflected southward, towards Zoar, in wide valley of the older north-flowing stream. Then this flood of water increased by that from Conotton Creek were forced over a col to the westward and thus cut the gorge-like valley from Zoarville to Dover. The old divide was located near the present Dover dam. This constricted valley, so new in appearance, most probably was cut late in the advance of the Wisconsin ice sheet.

From Dover to Tuscarawas village the present Tuscarawas River flows in reverse direction to that of the old Cleveland River and at a much higher level. The accumulated waters from Sandy and Conotton Creeks with that from the upper courses of Stillwater Creek were sufficient to flow headward up a tributary of the post-Illinoian Muskingum River which provided an outlet to the master stream, the Ohio River. This passage way, however, is not like others of known recent origin. The valley from Tuscarawas village to Coshocton has about normal width and its floor is quite deeply degraded. In these respects this part of the valley more nearly resembles the work of a Deep Stage than a Wisconsin Stage Stream.

MUSKINGUM RIVER

As the post-Illinoian Muskingum River proper was not reached by the Wisconsin ice no important modifications were necessary to take care of the waters from the melting ice. The main work accomplished was in discharging much outwash, silt, sand and gravel, for thick deposits along the valley. These accumulations are now represented by the high-level terraces very evident locally from Coshocton to Marietta.

HOCKING RIVER

The post-Illinoian Hocking River was beyond the influence of major changes through the Wisconsin glacier. Only the headwater streams were directly affected. The valley, however, received some contribution in the way of outwash materials. Further, a few shifts in the line of drainage appear, the most important being new ways near Rockbridge in Hocking County and at "The Plains" in Athens County.

SCIOTO RIVER

The Wisconsin ice pushed southward to Chillicothe obliterating of course all drainage lines north of this place. As the post-Illinoian Scioto valley from Chillicothe to Portsmouth was especially wide and open—the work of both Teays and Deep Stage erosion—the main accomplishment from the last ice invasion was the piling up of additional masses of silt, sand and gravel, locally a hundred or more feet in thickness. These deposits are now represented in the high terraces along the valley walls.

TERRACES

One of the results of the ice invasions is that the present streams are in general degrading in character, that is, they are still busily engaged in removing this filling of outwash material. Through such action many fine terraces are found along these valleys. From one to four well defined terraces may be recognized. This is especially true along the Ohio River across the reach of the state, along the Tuscarawas-Muskingum from Zoar to Marietta, along the Hocking from Lancaster to Hockingport and along the Scioto from Chillicothe to Portsmouth.

SUMMARY

The physiography of Southeastern Ohio thus presents a story with the degrading agencies of nature, with rock strata of different kinds and various densities, with uplifts by the great forces that build land surfaces and with repeated glaciation with profound modifications as the prime factors in leaving a surface with a multiplicity of features that attract attention and call for explanation. Few other regions are so rich in a jumble of markings of natural events. Many contributing elements are far from clear but this uncertainty adds to the interest of the story and allows for new interpretations by other workers. Southeastern Ohio thus offers much for the student of physiography, geology, botany, biology and kindred sciences.

REFERENCES

S. P. Hildreth. Geological Survey of Ohio, Report of 1838, page 50.

Edward Orton. Geological Survey of Ohio, Vol. III, 1878, page 381. Geology of Warren County.

M. R. Read. Geological Survey of Ohio, Vol. III, 1878, pages 325–326. Geology of Knox County.

P. Max Foshay. American Journal of Science, 1890, Vol. XL, November. Preglacial Drainage and Recent History of Western Pennsylvania.

T. C. Chamberlin and F. Leverett. American Journal of Science, Vol. XLVII, April, 1894. Further Studies of the Drainage Features of the Upper Ohio Basin.

R. R. Rice. American Journal of Science, 1895, Vol. XLIX, February. The Inner Gorge Terraces of the Upper Ohio and Beaver Rivers.

W. G. Tight. Bulletin Denison University, 1897, Vol. VIII, Part 2. A Contribution to the Knowledge of the Preglacial Drainage of Ohio.

J. A. Bownocker. American Geologist, 1899, Vol. XXIII, March. A Deep Preglacial Channel in Western Ohio and Eastern Indiana.

H. J. Davis. Bulletin Denison University, 1890, Vol. XI. Modifications in the Jonathan Creek Drainage Basin.

W. G. Tight. Ohio State Academy of Science, 1900. Special Papers No. 3, December. Some Drainage Modifications in Washington and Adjacent Counties.

J. A. Bownocker. Ohio State Academy of Science, 1900. Special Papers No. 3, December. History of the Little Miami River.

J. H. Todd. Ohio State Academy of Science, 1900. Special Papers No. 3, December. Some Observations of the Preglacial Drainage of Wayne and Adjacent Counties.

Gerard Fowke. Ohio State Academy of Science, 1900. Special Papers No. 3, December. Preglacial Drainage Conditions in the Vicinity of Cincinnati, Ohio.

Frank Leverett. United States Geological Survey, 1902. Monograph XLI. Glacial Formations and Glacial Features of the Erie and Ohio Basins.

W. B. Clark. Bulletin Denison University, 1902, Vol. XII, June. Drainage Modifications in Knox, Licking and Coshocton Counties.

W. G. Tight. United States Geological Survey, 1903. Professional Paper No. 13, Drainage Modifications in Southeastern Ohio and Adjacent Parts of West Virginia and Kentucky.

M. L. Campbell. Geological Society of America, 1903, Bulletin 14, Geographic Development of Northern Pennsylvania and Southern New York.

E. R. Scheffel. Bulletin, Denison University, 1908, Vol. XXV, Series 4. Ancient Finger Lakes in Ohio.

J. E. Hyde. Geological Survey of Ohio, 1921. Fourth Series, Bulletin 23, Geology of Camp Sherman Quadrangle

G. W. Conrey. Geological Survey of Ohio, 1921. Fourth Series, Bulletin 24, Geology of Wayne County.

Wilber Stout and R. E. Lamborn. Geological Survey of Ohio, 1924. Fourth Series, Bulletin 28, Geology of Columbiana County.

Wilber Stout. Geological Survey of Ohio, 1927. Fourth Series, Bulletin 31, Geology of Vinton County.

R. E. Lamborn. Geological Survey of Ohio, 1930. Fourth Series, Bulletin 35, Geology of Jefferson County.

Karl Ver Steeg. Ohio Journal of Science, 1930, Vol. XXX, No. 5, September. Drainage Changes in the Vicinity of Wooster.

George N. Coffey. Ohio Journal of Science, 1930, Vol. XXX, No. 6, November. Preglacial, Interglacial and Postglacial Changes of Drainage in Northeast Ohio with Special Reference to the Upper Muskingum Drainage Basin.

Karl Ver Steeg. Pan-American Geologist, 1931, Vol. LV. Erosion Surfaces of Ohio.

Wilber Stout and Downs Schaaf. Geological Society of America, 1931, Vol. 42, September. Minford Silts of Southern Ohio.

Karl Ver Steeg. Ohio Journal of Science, 1931, Vol. XXXI, No. 5, September. Drainage Changes in the Vicinity of Loudonville, Ohio.

G. W. White. Ohio Journal of Science, 1931, Vol. XXXI, No. 6, November. Glaciation of Northern Holmes County.

Henry S. Sharp. Bulletin Denison University, 1932, Vol. XXXII, No. 10, June. The Geomorphic Development of Central Ohio.

R. E. Lamborn. Ohio Journal of Science, 1932, Vol. XXXII, No. 5, September. The Newark Drainage System in Knox, Licking, and Northern Fairfield Counties.

Robert Scranton and G. F. Lamb. Ohio Journal of Science, 1932, Vol. XXXII, No. 6, November. Ancient Drainage Between the Old Cuyahoga and Old Pittsburgh Rivers.

Stafford Happ. Journal of Geology, 1934, Vol. XLII, No. 1, January-February. Drainage History of Southeastern Ohio and adjacent West Virginia.

W. Storrs Cole. Journal of Geology, 1934, Vol. XLII, No. 1, January-February. Identification of Erosion Surfaces in Eastern and Southern Ohio.

George W. White. Ohio Journal of Science, 1934, Vol. XXXIV, No. 6, November. Drainage History of North Central Ohio.

Guy-Harold Smith. Geographical Review, 1935, Vol. XXV. Relative Relief of Ohio.

W. Storrs Cole. Journal of Geology, 1935, Vol. XLIII, No. 8, November-December. Rock Resistance and Peneplain Expression.

COPPER SOLUTIONS FOR MICROSCOPICAL DETECTION OF GLUCOSE AND FRUCTOSE*

ELIZABETH S. BRETZ

PROBLEM

A number of copper reagents have been proposed for distinguishing glucose from fructose. Since the distinction depends upon the relative rate of oxidation of the two sugars, the tests will necessarily be influenced by concentration of sugar, time, temperature, and concentration of reagent. For a microscopical detection of these sugars, the problem therefore is to find the temperature and time of reaction at which these sugars may be most readily distinguished when they occur at different concentrations. Methyl fructosazone may be used to distinguish glucose from fructose; but because the copper tests are much more sensitive for microscopical work, it seems important to have more definite knowledge about their possibilities and limitations.

REAGENTS

The copper reagents proposed by Ost, Pieraerts, and Benedict for macroscopical tests and the one proposed by Flückiger for microscopical tests for sugars in plant cells were employed. A brief account of the composition and of the results reported for these reagents follows.

1. *Flückiger's copper tartrate reagent* (2, p. 272). Copper tartrate is prepared by mixing a solution of 30 gm. copper sulfate in 300 cc. hot water with a solution of 70 gm. potassium sodium tartrate in 200 cc. hot water. The precipitate is filtered, dried in a desiccator, and kept in a brown bottle. For each separate test a few crystals of copper tartrate are placed on a slide in a drop of 20 per cent sodium hydroxide. When the copper tartrate has dissolved, a drop or small section of the material to be tested is added. According to Flückiger (2, p. 272), reduction by fructose occurs immediately at room temperature and by glucose very soon with slight warming.

In order to have a uniform reagent for comparative tests the procedure may be modified by preparing standard solutions. If the latter procedure is followed, the solution should be renewed daily, as autoreduction slowly occurs in the solution. Since autoreduction increases with an increase in concentration of copper tartrate in the reagent, the amount of copper tartrate present should not greatly exceed the amount necessary to oxidize the sugar in the test object.

*Papers from the Department of Botany, The Ohio State University, No. 389.

Lampe (6, p. 347), by using a "sky-blue" solution, obtained the maximum amount of cuprous oxide with fructose in 7 minutes at room temperature and with glucose in 3 minutes at 45° C. The solutions used in the present tests were 0.05 gm. copper tartrate in 10 cc. of 20 per cent sodium hydroxide and 0.05 gm. copper tartrate in 20 cc. of 20 per cent sodium hydroxide.

2. *Ost's copper carbonate reagent* (7, p. 840, footnote 2). To 700 cc. boiling water 250 gm. potassium carbonate is gradually added. To that solution 100 gm. potassium bicarbonate is slowly added until it completely dissolves. A solution of 17 5 gm. copper sulfate in 100 to 150 cc. water is then added under vigorous agitation. After cooling, the solution is made up to 1000 cc. and filtered. Klein (4, p. 779) says this reagent reduces with gentle warming only ketoses. Zerban and Sattler (8, p. 307) made macrochemical tests using Nijns' modification of the above solution. This contained 15 gm. copper sulfate instead of the 17.5 gm. used by Ost. They placed 20 cc. sugar solution—containing not over 0.3 per cent fructose—in 50 cc. of the copper reagent previously warmed in a small Erlenmeyer flask to 48.5° C. to 49° C. After 2.5 hours at that temperature the cuprous oxide obtained was weighed. Zerban and Sattler (8, p. 308) found that with about equal quantities of glucose and fructose, 1 mg. of glucose reduces about one-thirteenth the amount of copper reduced by 1 mg. of fructose. The reducing effect per mg. of glucose decreases as the concentration of glucose increases, and also as the concentration of fructose in the mixture increases.

3. *Pieraerts' modification of Ost's reagent* (7, p. 840). The solution is prepared in the same way as Ost's reagent, but the amounts of the salts are changed to 140 gm. potassium carbonate, 100 gm. potassium bicarbonate, and 15 gm. copper sulfate. The reagent deposits basic copper carbonate after 24 hours. It must be renewed weekly (7, p. 851). Tests made by Pieraerts in the cold (13° C. to 16° C.) were examined every 15 minutes during the first 6 hours, thereafter on the ninth, twelfth, and twenty-fourth hours (7, p. 837). According to Pieraerts, in the cold glucose does not reduce the reagent in 24 hours. while 4 to 5 per cent fructose reduces it in 1 hour, 3 per cent in 1.5 hours, 2 per cent in 2 hours, and 1 per cent in 2.25 hours. Pentoses cause reduction in 4 hours in the cold (7, p. 842). Tests made by Pieraerts on a water bath were examined as reduction became evident. At the end of 1 hour the tests were concluded (7, p. 837). He states that glucose gives no precipitate of cuprous oxide at 30° C., 35° C., 40° C., or 45° C. Above 50° C. there is reduction (7, p. 842). At 30° C. 1 to 5 per cent fructose reduces the reagent by the end of 1 hour. Pentoses cause no reduction at this temperature in 1 hour, but at 35° C. they do reduce the reagent in 1 hour (7, p. 843). Pieraerts summarizes (7, pp. 846-847) the use of his modification of Ost's solution by saying that it can distinguish 1 to 5 per cent free fructose in the presence of other natural sugars, pentoses excepted, by heating 1 hour at 35° C. If pentoses are present, it is still possible to identify free fructose in 2.5 hours in the cold, or in 1 hour at 30° C. One is surprised, then, to read Pieraerts' statement (7, p. 847) that the diagnosis of fructose is

impossible if less than 20 per cent of that hexose is present, especially if pentoses are also in the mixture.

4. *Benedict's copper citrate reagent* (1, p. 486). A solution is made of 173 gm. sodium citrate and 100 gm. anhydrous sodium carbonate by heating in 600 cc. water. This is filtered if necessary and made up to 850 cc. A solution of 17.3 gm. copper sulfate in 100 cc. water is diluted to 150 cc. The copper sulfate solution is poured slowly with constant stirring into the carbonate-citrate solution. The mixture is ready for use and does not deteriorate on standing. It is not caustic and may be kept in cork or glass stoppered bottles. Upon reduction the solution is apt to yield green or yellow hydrated cuprous oxide, rather than the red anhydrous oxide.

Kolthoff (5, p. 888), working with 1 cc. sugar solution in 5 cc. of Benedict's reagent, could distinguish 1 per cent fructose from glucose and lactose after heating 0.5 hour at 37° C. to 40° C., but with 0.5 per cent the distinction was doubtful. At room temperature for 24 hours 0.5 per cent fructose was distinctly evident, 0.2 per cent gave a very slight reaction, and 0.1 per cent gave no apparent test. According to Klein (4, p. 780), copper solutions containing citric or tartaric acid are extremely photosensitive. Before beginning a test it should be determined whether autoreduction has occurred.

5. *Pieraerts' copper-glycocol reagent* (7, p. 841). To a solution of 12 gm. glycocol in hot water one adds little by little 6 gm. freshly prepared cupric hydroxide, which dissolves almost completely after 15 minutes on a steam bath. The solution, cooled to 60° C., is added to 50 gm. potassium carbonate, made up of 1000 cc., and filtered. The liquid keeps very well. If the potassium carbonate is added at a temperature higher than 60° C. there will be a precipitate of carbonic anhydride, which greatly diminishes the sensitivity of the reaction.

In the preparation of cupric hydroxide for the above reagent certain precautions are necessary to prevent its immediate oxidation. Add 5 per cent of ammonium chloride to 5 per cent copper sulfate solution. Pour this into 20 per cent sodium hydroxide. Wash the precipitate on a Buchner funnel with cold water. Keep the funnel covered to prevent oxidation. Drying the precipitate in an oven will hasten oxidation. It is best to dry the precipitate on a suction filter, weigh, and use it immediately.

Pieraerts (7, p. 845) says that free fructose forms an abundant precipitate of cuprous oxide in the cold after 24 hours and is the only natural sugar which does so. The results are uncertain with heat. One cannot trust the indications at 30° C. for an hour, if more than 3 per cent fructose is present.

METHODS

The concentrations of glucose and fructose used were 0.1 per cent, 0.5 per cent, 1 per cent, 5 per cent, and 10 per cent. The three temperatures used were room temperature, 40° C., and that of a steam bath. Slides at room temperature were kept in a moist chamber to prevent drying. One drop of sugar solution was thoroughly mixed with two drops of copper reagent on a microscopic slide.

Accurate counts were made of the cuprous oxide crystals obtained in each test. A description of the method of counting is not included in this paper, since the objective is chiefly to indicate with which reagents differentiation between glucose and fructose can be obtained.

In Flückiger's reagent it was not known what proportions of copper tartrate and sodium hydroxide would give the best results. Two solutions were tried, 0.05 gm. copper tartrate in 10 cc. of 20 per cent sodium hydroxide solution, and 0.05 gm. copper tartrate in 20 cc. of 20 per cent sodium hydroxide solution. The first solution did not give differentiation between 10 per cent glucose and fructose. The solution of 0.05 gm. in 20 cc. gave differentiation at all concentrations at room temperature.

DISCUSSION

The following paragraphs point out discrepancies in the results of the present microscopic tests and the results of the macroscopic tests mentioned in the section on reagents.

Ost's copper carbonate reagent was not found to reduce "only ketoses" with gentle warming, as reported by Klein, although at 40° C. there was good differentiation between the sugars at all concentrations.

Pieraerts' modification of Ost's reagent was found to be reduced by glucose to some extent at room temperature and at 40° C., contrary to the macroscopical observations of Pieraerts. It should be noted, however, that Pieraerts' room temperature was 13° C. to 16° C., while that of the present tests was about 25° C.

Benedict's copper citrate reagent gave differentiation between glucose and fructose at 0.1 per cent and 0.5 per cent at room temperature and at 40° C. when used in microscopical mounts, whereas Kolthoff, working macroscopically, failed to find differentiation at these low concentrations, except in the case of 0.5 per cent at room temperature.

Pieraerts' copper-glycocol reagent, recommended by Pieraerts for use at room temperature in distinguishing fructose from glucose, failed to do so in the present tests at 0.5 per cent and at 1 per cent. Even more cuprous oxide was reduced by glucose than by fructose in some cases. Differences in the size of the crystals obtained made it difficult to compare the amount of precipitate.

SUMMARY OF RESULTS

1. Five copper reagents were tested at the temperature of a steam bath, at 40° C., and at room temperature as to their use in distinguishing between 0.1 per cent, 0.5 per cent,

1 per cent, 5 per cent, and 10 per cent glucose and fructose in microscopical mounts.

2. None of the reagents gave positive tests only for fructose. Positive tests for glucose varied from zero to a copious precipitate, depending upon the temperature and concentration of the sugar.

3. Each of the reagents may be used for distinguishing glucose from fructose under certain conditions of temperature and concentration of the sugars.

4. All except Pieraerts' copper-glycocol reagent gave differentiation between glucose and fructose at room temperature at all concentrations. None of the reagents gave differentiation with steam at all concentrations. Flückiger's copper tartrate reagent and Pieraerts' copper-glycocol reagent failed to give differentiation at 40° C. at all concentrations.

5. Table I indicates the time interval in relation to different temperatures at which the reagents are useful in distinguishing between glucose and fructose at different concentrations.

TABLE I

DIFFERENTIATION BETWEEN GLUCOSE AND FRUCTOSE

REAGENT AND TEMPERATURE	TIME IN MINUTES AT WHICH DIFFERENTIATION APPEARS — CONCENTRATION OF SUGAR SOLUTION				
	0.1 per cent	0.5 per cent	1 per cent	5 per cent	10 per cent
Flückiger's Room Temp.......	15–60..*	4–15	4–60..	4–60..	4–60..
Ost's Copper Carbonate					
Steam bath................	¼–2..	¼–2..	¼–2..		
40° C...	30–60	30–60	15–60	5–1440..	5–1440..
Room Temp................	120	1440..	120-1440..	60–1440..	60–1440..
Pieraerts' Modification of Ost's.					
Steam bath................	½–1..	½			
40° C......................	30–60..	15–60..	10–60..	5–60..	2–60..
Room Temp................	30–120..	15–120..	15–120..	15–120..	7–120..
Benedict's Copper Citrate.					
40° C......................	10–60..	5–60..	5–60..	5–60..	5–60..
Room Temp................	60..	60..	60..	60..	30–60..
Pieraerts' Copper-Glycocol.					
40° C......................		60	30–60	10–60	10–60
Room Temp................	1440..			60	10–60

*Two periods (..) after a figure indicate that no tests were made for a longer time interval. Where there are no periods the last figure given is the longest time interval in which there was good differentiation, as shown by further tests.

The writer wishes to express her appreciation to Dr. H. C. Sampson, of the Department of Botany of The Ohio State University, for his assistance in the direction of the experimental work and in the preparation of this paper.

LITERATURE CITED

(1) **Benedict, Stanley R.** A Reagent for the Detection of Reducing Sugars. Journal of Biological Chemistry, V: 485–487. 1908–09.
(2) **Flückiger, F. A. and Tschitch, A.** The Principles of Pharmacognosy. Power, F. B., tr. New York: William Wood and Co. 1887.
(3) **Haar, A. W. van der.** Anleitung zum Nachweis, zur Trennung und Bestimmung der reinen und aus Glukosiden usw. erhaltenen Monosaccharide und Aldehydsäuren. Berlin: Gebrüder Borntraeger. 1920.
(4) **Klein, G.** Handbuch der Pflanzenanalyse II. Berlin: Julius Springer. 1932.
(5) **Kolthoff, I. M.** De reduceerende werking der suikers. Chemisch Weekblad XIII: 887–895. 1916.
(6) **Lampe, L.** A Microchemical and Morphological Study of the Developing Endosperm of Maize. Botanical Gazette, XCI: 337–376. 1931.
(7) **Pieraerts, M. J.** Diagnose du d-fructose en presence d'autres sucres naturels. Bulletin de l'Association des Chimistes de Sucrerie et de Distillerie de France et des Colonies. July, 1907–June, 1908: 830–848.
(8) **Zerban, B. W. and Sattler, Louis.** Effect of Dextrose and Sucrose on the Determination of Levulose by Nijns' Method. Industrial and Engineering Chemistry, Analytical Edition II: 307–309. 1930.

The Fungi

Students of mycology and plant pathology will find the enlarged second edition of this text especially useful. It enables the student to visualize the entire fungus field and the relationship of one order to another. It is probably too advanced for most undergraduates.

Early in the text the authors define and limit the use of the technical terms which are later employed in the discussion of asexual and sexual reproductive structures. An excellent chapter, such as is seldom found in texts by American authors, on the physiology of saprophytism, parasitism and symbiotic relationships, is included. The author discusses the reproductive structures of each important order in sequence, beginning with the Archimycetes of the Phycomycetes. Many American mycologists place the Archimycetes in a separate class, but in this text they are included in the Phycomycetes as a sub-class of equal rank with the Oomycetes and Zygomycetes. Other minor changes in classifications exist, but one might expect British mycologists to have different viewpoints from ours on the relationship of some of the fungus groups.

Usable keys whereby the student may readily distinguish the different orders are found throughout. The volume is well illustrated by author's drawings and by figures reproduced from publications of mycologists past and present.

In the concluding chapter mycological techniques such as isolation, single spore culture, and the use of fixatives, stains, and the various types of media are discussed. The citations are well chosen and appear to be entirely adequate, in as much as there are forty pages of them. The book is lucidly written and, taken in its entirety, has many commendable features. It is printed on a good grade of paper and is securely bound.—*A. L. Pierstorff.*

The Structure and Development of the Fungi, by H. C. I. Gwynne-Vaughan and B. Barnes. xvi+449 pp. Cambridge at the University Press, in New York, the MacMillan Company, 1937. $5.50.

STUDIES OF THE GENUS EMPOASCA[1] (HOMOPTERA, CICADELLIDAE)

PART V

TWELVE NEW SPECIES OF EMPOASCA FROM THE UNITED STATES

RALPH H. DAVIDSON AND DWIGHT M. DELONG
The Ohio State University

A continuation of the study of the Genus *Empoasca* has brought to light several species which have apparently not previously been described. The present group of species contains material from various portions of the United States.

Empoasca mucronata n. sp.

Resembling *pyramidata* but with more narrowed apical portion of pygofer spine. Length, 4 mm.

Vertex produced and bluntly rounded, almost twice as wide between eyes as median length, produced one half its length before anterior margin of eyes.

Color: Pale to dull green, often marked with the three pale longitudinal stripes on the vertex, the three pale spots on anterior margin of pronotum and the median broad pale stripe on the scutellum.

Genitalia: Male plates narrowed on apical half and with narrow rounded apices. Lateral processes curved concavely outward with the apices directed outwardly. Pygofer spine with a broad, short basal portion at the caudal ventral edge of which a short narrow spine arises and is directed ventrally.

Holotype male, Pickaway Co., Ohio, June 24, 1934 (J. S. Caldwell), in DeLong collection. Paratype males same locality and date and Oakwood, Illinois, Aug. 17, 1934 (DeLong and Ross), in DeLong collection and Illinois Natural History Survey collection.

Empoasca curvatura n. sp.

Resembling *pyramidata* and *distracta* but with aedeagus more enlarged at apex and pygofer spine more narrowed apically. Length, 3.2 mm.

Vertex produced, bluntly angled, twice as wide as median length, produced almost one half its length before anterior margin of the eyes.

Color:, Dull green with three white longitudinal areas on vertex and three anterior white spots on anterior margin of pronotum. Scutellum with broad longitudinal median white stripe and a transverse band just before apex.

Genitalia: Female last ventral segment broadly roundedly produced. Male plates rather long, apices blunt and narrowed. Lateral processes

[1]Previous studies of the group are summarized in Ohio Journal of Science 36: 225, July, 1936, and 32: 29, January, 1935.

curved concavely outward and overlapping near apex. Pygofer spines rather short, abruptly narrowed and produced into a ventrally directed apical spine. Anterior margin concavely, broadly notched.

Holotype male from Taylor Falls, Minnesota, August 16, 1916 (DeLong), allotype female, Urbana, Illinois (Jones) and paratype males and female from Urbana, Illinois (Jones) and Athens, Ohio (Stehr) in the DeLong collection.

Empoasca orthodens n. sp.

Resembling *bifurcata* in general appearance and internal male genitalia, but with a distinct pygofer spine. Length, 3.5 mm.

Vertex rather strongly produced and bluntly angled. Two-thirds as long at middle as basal width between eyes. Produced two-thirds its length before anterior margins of the eyes.

Color: Dull yellowish-green. Vertex with a pale blotch next either eye. Pronotum with three pale spots on anterior margin.

Genitalia: Male with long plates, apices rounded and slightly diverging. Lateral processes of pygofeıs curved concavely outward, apices rather abruptly narrowed and narrowly produced for a short distance. Pygofer spine rather long curved caudally and dorsally forming a spine like apex. Also a short straight spine arising ventrally and extending ventrad.

Holotype male from Putnam, Illinois, collected by Ross and DeLong July 6, 1934, in the collection of the Illinois Natural History Survey.

Empoasca bicuspida n. sp.

Resembling *bifurcata* and *orthodens* but smaller in size and with shorter posterior spine of the bifurcate pair and different lateral processes. Length, 3 mm.

Vertex produced and rounded at apex, a little wider between eyes than length at middle. Almost as long at middle as basal width between eyes.

Color: Dull green, often washed with golden yellow without pale markings. Anterior margin of pronotum often with three pale spots.

Genitalia: Female last ventral segment with posterior margin roundedly produced. Male plates rather narrow, tapered and bluntly pointed. Lateral processes vermiculate as in *bifurcata*. Pygofer spines with bifurcate apex, the posterior spine of the bifurcate pair comparatively short.

Holotype male and allotype female Belle Glade, Florida, 1929 (Clifton) in the DeLong collection. Paratype male and female specimens from Spavina, Oklahoma, St. Petersburg (Osborn), Gainesville (Osborn), Cocoanut Grove (Breakey), Miami (Breakey), Dade Co. (Breakey), and Belle Glade (Clifton), Florida, in the DeLong, Osborn and Breakey collections.

Empoasca latarca n. sp.

Resembling *bifurcata* but more robust and with lateral processes and spine of pygofer more like those of the species of Kybos. Length, 3.5 mm.

Vertex roundedly produced, about one-fourth wider between eyes

at base than median length, produced almost one-half its length before anterior margin of eyes.

Color green, vertex with central pale median stripe and a pair of divergent pale stripes. Pronotum with three pale spots on anterior margin. Scutellum with a pale transverse band near apex.

Genitalia: Female last ventral segment roundedly produced. Male plates broad at apex and well rounded. Lateral processes concave on inner margin at apex. In lateral view appearing narrowed and concave before apex which is sharply pointed. Pygofer spines strongly rounded, notched on anterior ventral margin forming a rather long gradually tapered apical spine with the apex sharp pointed and directed anteriorly.

Holotype male from Chicago, Illinois, 1905 (Sanders), allotype female Urbana, Illinois, 1937 (Jones) and Washington, D. C., 1906 (Sanders), in DeLong collection. Male paratypes, Apple River Canyon, 1934, and Warren, Illinois, 1934 (Frison and Douglas), in Illinois Natural History Survey collection.

Empoasca biarca n. sp.

Resembling *ponderosa* in general appearance and shape of the lateral processes but with a twice curved pygofer spine and without the caudal spine on oedeagus. Length, 3.5–4 mm.

Vertex weakly produced and well rounded, a little more than half as long at middle as basal width between eyes, produced about one-third its length before anterior margin of eyes.

Color: Dull green to golden yellow without definite markings.

Genitalia: Female last ventral segment with posterior margin roundedly produced. Male plates with bluntly pointed apices. Lateral process straight as in *coccinea*. Pygofer spines long, gradually tapered, twice curved on anterior margin, apex slender, curved anteriorly.

Male holotype, San Francisco Co., California, July 25, 1912 (Ball), Allotype female, Colfax, California, June 23, 1908 (Ball) and paratypes from Colfax, California and Chilcoat, California, in Ball collection. Paratype male and female Colfax, California, in DeLong collection.

Empoasca perlonga n. sp.

Resembling *coccinea* in general appearance and shape of lateral processes but with a very long, slender characteristic spine. Length, 3 mm.

Vertex weakly produced, broadly, bluntly angled. A little wider between eyes at base than median length, produced about one-third its length before anterior margin of the eyes.

Color: Dull sordid green washed with yellow and without definite markings.

Genitalia: Female last ventral segment with posterior margin roundedly produced. Male plates rather narrow with rounded apices. Lateral processes straight as in *coccinea*. Pygofer spines very long, broad at base, abruptly narrowed and produced as a long, slender, ventrally directed spine.

Holotype male and allotype female, Cantwell Cliffs, Ohio, June 24, 1922 (DeLong) and paratype male and female same place and date, in DeLong collection. Paratype males, Neotoma, Hocking Co. (Thomas) in Osborn collection.

Empoasca caverna n. sp.

Resembling *fabae* in general appearance but with lateral processes concave on outer margin at apex and with spine broader at base and more abruptly narrowed. Length, 3.5 mm.

Vertex bluntly produced, about one-third wider between eyes than median length, produced one-half its length before anterior margin of eyes.

Color: Green washed with yellow, vertex with a median pale longitudinal stripe, a pair of pale spots at apex and a pair at base. Pronotum with three pale spots on anterior margin. Elytra with pale fuscous spot at middle.

Genitalia: Male plates broadened at middle, concavely narrowed on apical half to rather broad rounded apices. Lateral processes strongly, abruptly, concavely narrowed on outer margin forming slender pointed apices which are sometimes overlapped. Pygofer spine broad at base, abruptly narrowed to form apical slender spine which is directed ventrally and as long as basal portion.

Holotype male, Warren, Illinois, August 22, 1936 (DeLong and Ross), in the Illinois Natural History Survey collection.

Empoasca decurvata n. sp.

Resembling *curvata* both in general appearance and internal male genitalia but with characteristic lateral processes and longer pygofer spine. Length, 3.5 mm.

Vertex produced and angled, one-third longer on middle than width between the eyes, produced about one-half its length before the anterior margin of the eyes.

Color: Green, vertex with a central stripe, two apical oblique and two basal oblique white dashes. Pronotum with three anterior white spots. Scutellum with central third occupied by a broad white longitudinal stripe.

Genitalia: Female last ventral segment strongly, roundedly produced. Male plates rather broadly rounded at apex. Lateral processes in ventral view rather strongly curved inwardly with the apices curved abruptly outwardly and extending laterally. Spines of pygofer long, gradually narrowed, apical half produced as a narrow spine extending ventrally and curved slightly anteriorly.

Holotype male and allotype female, Clarksville, Tennessee, July 14, 1915, and paratypes from Clarksville and Colliersville, Tennessee, are in the DeLong collection. Male and female paratypes, Douglas Co., Kansas, in the Snow Collection, University of Kansas.

Empoasca pergrada n. sp.

Resembling *panda* both externally and internally. The lateral processes more broadened at apex and the pygofer spine more tapered to apical portion. Length, 3 mm.

Vertex strongly produced and bluntly angled, two-thirds as long as basal width, produced one-half its length before anterior margin of eyes.

Color: Pale yellowish-green, usually with the three longitudinal pale areas on the vertex, the three pale spots on anterior margin of pronotum and a transverse pale spot on scutellum.

Genitalia: Female last ventral segment roundedly produced. Male plates well rounded at apex. Lateral processes narrowed at apex, apices bent obliquely inwardly, usually overlapping. Pygofer spines broad at base, abruptly narrowed so that apical half forms a slender spine which is directed obliquely ventro-anteriorly.

Holotype male, Decatur, Georgia (Auten), allotype female, Taylor's Falls, Minnesota, August 16, 1916 (DeLong) and paratype males and females, Taylor's Falls, Minnesota, Biloxi, Mississippi (Grimes), in DeLong collection. Male paratypes, Alton and White Pine Forest Park, Illinois (Ross, Frison, DeLong), in Illinois Natural History Survey collection.

Empoasca luda n. sp.

Resembling *smaragdula* in size and internal male genitalia, but with a broad, short spine. Length, 4.2 mm.

Vertex broadly rounded, more than twice as broad as median length, produced about one-third its length before anterior margin of eyes.

Color: Dull green washed with yellow and brown. Vertex, pronotum and scutellum predominantly brownish with yellowish-green paler areas. Elytra dull green, veins brown.

Genitalia: Male plates with well rounded apices. Lateral processes straight, pointed at apices. Pygofer spines broad, deeply rounded, notched on anterior apical half forming a curved spine on ventral caudal margin which is directed ventrally with the apex pointing anteriorly.

Holotype male, Wooster, Ohio (Houser) taken in galleries of *Crabro davidsoni* and paratype male Urbana, Illinois, 1917, in DeLong collection.

Empoasca excava n. sp.

Resembling *digita* externally but with lateral processes roundedly, abruptly narrowed at apex, concave ventrally and on outer margin with apices turned outwardly. Length, 4 mm.

Vertex broadly rounded, slightly produced, more than twice wider than median length and produced about one-third its length before anterior margin of eyes.

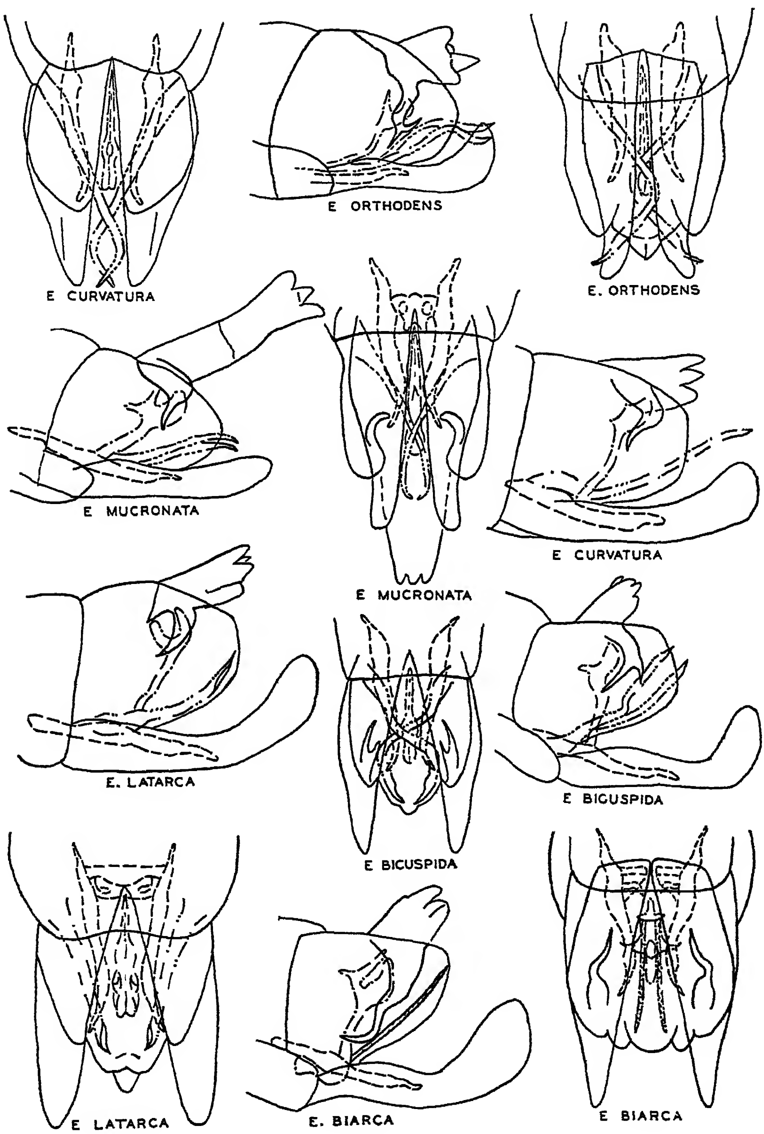
Color: Dull green washed with golden yellow, pronotum often with the three pale areas on anterior margin, the median one often forming a pale stripe, and scutellum with longitudinal pale stripe.

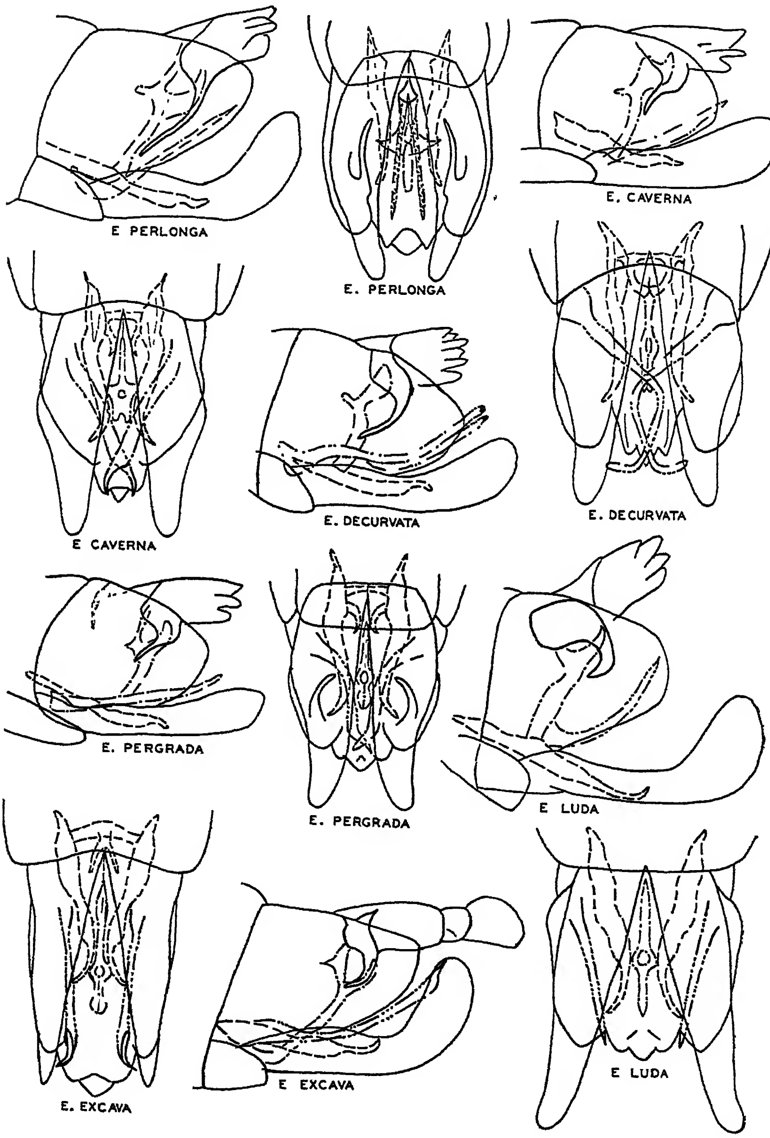
Genitalia: Female last ventral segment roundedly produced. Male plates long, gradually tapered to bluntly pointed apices. Lateral processes narrowed near apex with tips slender and pointed outwardly, process concave ventrally and on outer margins at apex. Pygofer spine rather short, abruptly narrow at about half its length on anterior margin with apex curved anteriorly.

Holotype male from Clarksville, Tennessee, July, 1915 (DeLong), allotype female LaPrelle, Texas, November (Knull) and male and female paratypes Oklahoma (Standish-Kaiser), Texas (Knull) and Tennessee (DeLong), in the DeLong collection. Male and female paratypes, Vienna, Ursa and Havana, Illinois (Ross, Mohr, Burks, DeLong), in Illinois Natural History Survey collection.

New Species of Empoasca
Ralph H. Davidson and Dwight M. DeLong

PLATE I




E PERLONGA
E. PERLONGA
E. CAVERNA
E CAVERNA
E. DECURVATA
E. DECURVATA
E. PERGRADA
E. PERGRADA
E LUDA
E. EXCAVA
E EXCAVA
E LUDA

FIVE NEW SPECIES OF COLEOPTERA
(Corynetidae, Elateridae and Buprestidae)

JOSEF N. KNULL
The Ohio State University, Columbus, Ohio

Pelonides similis n. sp.

Form and size of *P. humeralis* Horn; mouth parts, except last joints of palpi, thorax and part of elytra orange, apical third of elytra with a transverse piceous band which is produced in a narrow stripe along suture to basal fourth of elytra, scutellum, head, antennae, last joints of both palpi, ventral surface with exception of prothorax and legs, piceous.

Head convex; surface coarsely punctured, punctures separated by less than their own diameters; pubescence long; antennae ten-jointed, last three joints longer than all of others united, eighth and ninth joints triangular, slightly longer than wide, last joint nearly as long as eighth and ninth joints taken together; eyes finely granulate, emarginate in front.

Pronotum as long as wide, wider in front than at base; sides parallel in front, broadly rounded at base; disk convex; surface coarsely punctured, each puncture bearing a long silken hair. Scutellum rectangular, punctures small, sparse.

Elytra wider than pronotum, wider in rear than at base; sides divergent to broadly rounded apices; disk convex; surface covered with large granules, pubescence long.

First tarsal joint shorter than second.

Length, 4.8 mm.; width, 2 mm.

Described from two specimens collected in the Davis Mountains, Texas, June 2, 1937, by D. J. and J. N. Knull. Holotype and paratype in writer's collection.

Variations: The paratype has the elytra piceous with the exception of a transverse orange band at base which extends over umbone and down suture.

The species resembles *P. humeralis* Horn, but can be separated by the punctures of head and pronotum being much coarser. The species also lacks the dark central area on the pronotum of the type[1] and other specimens of *P. humeralis* Horn which I have seen.

Ampedus (Elater) obscurus n. sp.

Female.—Elongate, brunneus, mouth parts, antennae, legs and last two ventral segments of abdomen lighter, densely clothed with short brunneus pubescence.

---

[1]The writer is indebted to Mr. E. T. Cresson, Jr., of the Academy of Natural Science, for the privilege of studying the Horn types and also to Prof. H. C. Fall for examining the specimen.

Head coarsely, closely punctured; antennae not reaching hind angles of pronotum, scape stout, second joint longer than wide, third joint longer than second, fourth joint longer than third, joints four to ten inclusive of equal length, serrate, last joint longer than tenth.

Pronotum longer than wide, narrower in front than in rear, hind angles produced; sides broadly rounded in front, nearly parallel in basal half; disk convex, hind angles bicarinate; surface coarsely punctured in front and at sides, rest of area with punctures not well defined. Scutellum nearly round, finely punctured.

Elytra slightly narrower than pronotum; sides nearly parallel in front, broadly rounded back of middle; disk convex; surface with striae finely closely punctured, punctures separated by distances less than their own diameters, intervals finely punctured.

Beneath with abdominal segments densely finely punctured; prosternum convex, prosternal lobe broadly rounded.

Length, 7.1 mm.; width, 2 mm.

Described from one female specimen labeled Dixie National Forest, Nev., June 30, 1937, D. J. and J. N. Knull collectors, in collection of author.

This species[2] would probably stand next to *A. rhodopus* Lec., from which it can be separated by the lack of the strong punctures of the pronotum.

Anchastus uniquus n. sp.

Female.—Robust, depressed, shining, castaneous, clothed with light brown pubescence.

Head convex; surface coarsely punctured; eyes very small, finely granulate; antennae reaching to hind angles of pronotum when laid along side margins, scape stout, second joint longer than broad, third joint longer than second, fourth joint not as long as second and third united, joints four to ten inclusive of about equal length, serrate, eleventh joint longer than tenth.

Pronotum wider than long, wider at base than in front, hind angles strongly produced; sides broadly rounded in front, nearly parallel at base; disk convex, hind angles bicarinate, carinae of about equal length; surface densely coarsely punctured in front and along sides, punctures separated by less than their own diameters, other punctures light and separated by about their own diameters. Scutellum oval, coarsely punctured.

Elytra at base not as wide as base of pronotum, wider than pronotum back of middle; sides nearly parallel at base, broadly rounded posteriorly; disk convex; surface finely striate, punctures indistinct, intervals irregularly punctured, scabrous.

Beneath coarsely punctured in front, abdomen finely punctured, last segment very densely punctured; hind coxal plates strongly dilated internally; third tarsal segment bearing a large lobe beneath.

Length, 6 mm.; width, 2.2 mm.

Holotype female labeled Brownsville, Tex., August 8, 1937, D. J. and J. N. Knull, collectors, in collection of the author.

---

[2]The writer is indebted to Mr. W. J. Brown for the examination of material.

According to Van Dyke's key[3] this species would run to *A. sericans* Cand However, it can be distinguished by its smaller size, and shorter fourth antennal segment.

Agrilus shoemakeri n. sp.

Male.—Robust, dull bronze above and below, pubescence of elytra inconspicuous. Head strongly depressed in middle, coarsely punctured, becoming rugose on vertex; antennae short, not reaching middle of pronotum when laid along side margins, serrate from the fifth joint.

Pronotum as long as wide, apex and base of about equal width, widest in front of middle; sides broadly rounded in front, constricted at base, when viewed from the side, marginal and submarginal carinae separated in front but joined back to middle; anterior margin strongly lobed; basal margin trisinuate; disk convex, a strong median depression extending from back of apex to base, lateral depressions well marked, prehumeral carinae distinct; surface transversely rugose, punctures fine between rugae. Scutellum granulate, carina absent.

Elytra wider than base of pronotum; sides rounded in front, constricted in middle, broadly rounded posteriorly to rounded apices, margin serrate back of middle; disk convex, sutural margin elevated posteriorly, basal depressions well marked; surface imbricate.

Abdomen beneath transversely imbricate; first and part of second ventral slightly channeled; suture between first two ventrals not indicated at sides. Prosternal lobe broadly rounded, a line of long pubescence extending from prosternum to second abdominal segment. Hind coxae with posterior margin sinuate, outer posterior angle prolonged. Anterior and middle tibiae mucronate on inner margin at apex, posterior tarsi not longer than tibiae. Tarsal claws similar on all feet, cleft, the inner tooth slightly broader than the outer one.

Length, 5.8 mm.; width, 1.5 mm.

Described from one male specimen collected at Nogales, Santa Cruz Co., Ariz., August 31, 1906, by F. W. Numenmacher, in the collection of the late Chas. Schaeffer.

I take pleasure in naming this species after Mr. Ernest Shoemaker, to whom I am indebted for the specimen. Holotype in collection of writer.

According to Fisher's key[4] this species would run to *A. imbellis* Crotch. It can be separated by the median depression of pronotum. The genitalia resemble those of *A. illectus* Fall as figured by Fisher.

Agrilus neoprosopidus n. sp.

Male.—Size and form of *A. egenus* Gory, bronze, front bright green, each elytron with three indistinct pubescent spots, one in basal depression, one back of middle, and one on apical fourth along suture.

Head convex, no median depression; front granulate, vertex strongly punctured; antennae not reaching to middle of pronotum when laid along side margin, serrate from the fifth joint.

---

[3] E. C. Van Dyke, Proc. Calif. Acad. Sci. 22: 291–465, 1932.

[4] W. S. Fisher, U. S. Nat. Mus. Bul. 145, pp. 1–349, 1928.

Pronotum wider than long, widest in middle; wider at base than at apex; sides broadly rounded in front, constricted at base, when viewed from the side, marginal and submarginal carinae separated for their entire length; disk somewhat flattened, a slight impression in front of scutellum, lateral depressions well marked, prehumeral carinae prominent; surface obliquely strigate, punctures between strigae fine. Scutellum granulate, transversely carinate.

Elytra wider than base of pronotum; sides broadly rounded in front, constricted in middle, apices rounded, serrulate; disk convex, sutural margin elevated posteriorly; basal depressions well marked, surface imbricate, pubescence short.

Abdomen beneath lightly punctured, pubescence short, first two ventrals not modified. Prosternal lobe truncate, slightly emarginate; prosternal process with sides parallel to behind coxal cavities. Tibiae of first two pairs of legs mucronate on inner margin at apex. Tarsal claws similar on all feet, cleft, the inner tooth much broader than the outer one and not turned inward.

Length, 4.5 mm.; width, 1.1 mm.

Described from one male specimen collected at Brownsville, Texas, May 12, 1935, by the author. Holotype in writer's collection.

According to Fisher's key[4] this species would run to *A. prosopidus* Fisher. It can be separated by the male genitalia which resemble those of *A. paramasculinus* Knull as figured by Fisher. The pronotum is less convex.

Experimental Design and Statistical Analysis

The intimate relationship between the design or logical structure of an experiment and its statistical analysis is a new and rapidly progressing study. It becomes increasingly clear that the biologist should make himself thoroughly familiar with the methods of statistics *before* rather than after his experiments are performed. Professor Snedecor has taken advantage of every opportunity to discuss these "questions of design" in connection with the mathematical procedures discussed in his new manual.

The book has many other features which appeal to the biologist. The exposition is developmental and each statistical technique is illustrated with several sets of data drawn from a wide variety of experiments. Each chapter also includes many unworked exercises, together with answers. This makes it especially valuable as a manual for self-instruction or as a text. Mathematical questions are largely omitted. An arithmetical "proof" is preferred to an algebraic one. Special attention is given to methods of machine calculation.

Emphasis is placed upon the precise formulation of a null hypothesis upon which the statistical argument is rested. This tends to give the reader a clearer grasp of the underlying similarities of the various statistical operations which he performs. The all-important distinction between population parameters and sample statistics is insisted upon throughout. All of the methods are applicable to small scale experiments, being based upon the distributions of chi-square, t, and F, using the concept of degrees of freedom. Large sample approximations are introduced only as special cases.—*C. W. Cotterman.*

Statistical Methods, by George W. Snedecor. xiii+341 pp. Ames, Iowa, the Collegiate Press, Inc. 1937. $3.75.

THE OHIO JOURNAL OF SCIENCE

VOL. XXXVIII MAY, 1938 No. 3

THE MUSKINGUM WATERSHED CONSERVANCY DISTRICT

CHARLES C. HUNTINGTON
Department of Geography,
The Ohio State University

The Muskingum Watershed Conservancy District is an important example of co-operation for resources conservation by the Federal Government, a State, and the people of a local political subdivision. The Muskingum Watershed, a part of the Mississippi Drainage Basin, is the largest in Ohio, including 8,038 square miles. This area, together with the 289 square miles drained by Duck Creek, constitutes about one-fifth of the area of the state. Physiographically, it lies mostly in the unglaciated Appalachian Plateau, the northern and western part, however, being within the glaciated portion. (Plate I.) Politically, the Conservancy District consists of eighteen counties forming a political subdivision whose boundaries follow roughly those of the drainage basin.

From an economic and social point of view, this Conservancy District, created June 3, 1933, under the Conservancy Act of Ohio, passed soon after the great flood of 1913,[1] includes approximately half the major land-use problem areas of the State.[2] This very hilly section of Ohio was the first settled, but contains large areas not well adapted to arable farming on account of the difficulty of using modern farm machinery, the serious erosion due to the rapid run-off from long denuded slopes and the impoverished soils mostly of sandstone and shale origin.

The average yearly rainfall of the area is approximately 39 inches, but the run-off is high especially during the winter and

[1]Passed February 6, 1914, *Page's Annotated Ohio General Code*, Secs. 1–7994.

[2]*Major Land-Use Problem Areas and Land Utilization in Ohio*. Dept. of Rural Econ., O. S. U., and Ohio Agr. Exper. Sta. Mim. Bull. No. 79, Map, p. 2.

early spring rains, amounting to 86% for the March, 1913, storm and from 75% to 85% for that of March, 1933. Sherman's chart of mean precipitation and run-off for the years 1910–1918 shows a comparatively uniform rainfall distribution by months for the year, but a relatively high run-off from January to April with a maximum in March when the run-off was 90%.[3] The Soil Conservation Service reported a 95% run-off from plowed land in Ohio during the heavy rains of January, 1937.[4] This high run-off from steep slopes naturally increases the flood hazard.

The floods may be classed as summer floods that occur during the crop season, usually in localized areas, and winter and early spring floods which are more general and cause most of the damage. The summer rains are often heavy, but fortunately are usually localized within relatively small areas. Thus, on July 16, 1914, at Cambridge, Ohio, 7.09 inches fell in an hour and a half.[5] This remarkably intense storm was decidedly limited in area, however, decreasing rapidly in intensity in all directions until the half inch isohyet bounded it from three to five miles from the weather bureau station which just happened to be at the center of the storm.[6] Sudden and heavy summer rains are common in the Muskingum area, but being local, they are not so costly in flood totals. In fact, practically all of our major floods result from winter and spring rains, which, although perhaps of less intensity than the summer rains, may last longer and often fall on ground already wet or frozen.

At the beginning of the glacial period the surface of most of the Muskingum area had a greater relief than now; the rock floors of the pre-glacial valleys now are often buried 150 feet below the present valley bottoms.[7] The total relief of the unglaciated region, with its mature topography, however, still approximates 500 feet.[8] The surface of the old plateau, as indicated by the ridge tops, stands some 1,200 feet above the sea. The broad flat-bottomed valleys with their flood

[3]C. E. Sherman, *Ohio Stream Flow*, Part I, p. 6.

[4]C. F. Brooks and A. H. Thiessen. The Meteorology of Great Floods in the Eastern United States. *Geog. Rev.*, Apr., 1937, p. 272.

[5]W. H. Alexander, *A Climatological History of Ohio*, p. 78.

[6]C. E. Sherman, *The Ohio Water Problem*, p. 16.

[7]G. W. White. Drainage History of North-Central Ohio. *O. Jour. of Science*, Nov., 1934, p. 373.

[8]*Ibid.*, p. 367.

plains and terraces,[9] contain fertile farm lands, good roads and homes, also many towns and cities with their factories, potteries (Plate II, Fig. 2), and other industries—all hitherto subject to damage by flood.

In the March, 1913, flood, there were estimated direct damages of $13,600,000 within this District, and these were only a small part of the flood toll, with its loss of life and intangible damages of interrupted business and employment, to which should be added local, state and federal relief expenses. Counties and cities alone in the district spent over $3,000,000 to repair highways and bridges damaged by the flood of 1913. Other floods as in 1927 and 1933 added strong arguments for conservation.[10] In August, 1935, floods again ravaged the district—the damages of that month's flood within the Muskingum Basin have been estimated by engineers at $5,500,000. A suggestion of how the flood waters of that month affected business and transportation in the valleys of the District is given in Plate II, Fig. 3, which shows an urban scene where the Tuscarawas and Walhonding rivers join at Coshocton to form the Muskingum.

The difference between high and low water stages is 29 feet at Coshocton, 47.5 feet at Zanesville, 46.2 feet at McConnelsville, and 43.2 feet at Marietta. This great variation in the volume of the Muskingum is also indicated by the fact that while the average flow at its mouth is about 8,200 second-feet, the range is from a minimum of about 450 feet to a maximum of some 282,000 feet per second.[11]

The hydrographic pattern of the Muskingum Basin is such that, within a few days after heavy rains general over the drainage area, its two main branches and their wide-spreading tributaries rapidly concentrate the bulk of the run-off at Coshocton, 109 miles above the mouth of the Muskingum, and then at Dresden, where the Muskingum River, leaving the wide pre-Illinoian valley through which most of the basin above Zanesville formerly drained westward toward Newark, has cut its relatively narrow modern valley southward to Zanesville. Here, joined by the Licking and augmented by the

---

[9]Width, extent and character of many of these valleys may be seen clearly on the U. S. G. S. Topographic Sheets: Ohio Quadrangles of Millersburg, Uhrichsville, Coshocton, Newark, Frazeysburg and Marietta.

[10]W. T. Buckley, The Ohio River Flood of March, 1933. *O. Jour. of Sc.*, March, 1933, p. 67.

[11]C. E. Sherman, *Ohio Stream Flow*, Part I, p. 62.

waters of Wakatomika and Wills Creeks, main tributaries of the Muskingum between Coshocton and Zanesville, the Muskingum enters a still narrower gorge in which flood waters have risen higher above low water mark than in any other valley within the state. On March 28, 1913, for example, the flood water rose 44.8 feet above low water mark at Lock 10 at Zanesville.[12]

As a comprehensive program of flood control and water conservation, the Muskingum Watershed Conservancy District is developing a system involving a large key reservoir on each of the two main branches of the Muskingum, together with a dozen more on their tributary streams. (Plate I.) The plan is to have as nearly as practical, equal distribution throughout the basin of both water conservation and flood control. The project will control some two-thirds of the Walhonding and Tuscarawas drainage areas and five-sevenths of the whole Muskingum basin above Zanesville. These reservoirs, at maximum flood elevation, include 77,730 acres, of which 65% was flooded in 1913. The project is designed to protect against a storm 36% greater than that of 1913. That is, ten inches of rainfall in five days, in all parts of the basin above Zanesville, with a run-off of 90% or nine inches. This control would be sufficient to lower the flood crest below that of 1913 by 6.3 feet at Marietta, 10.6 feet at Coshocton, and 15.3 feet at Zanesville.[13] The 1913 storm was used as a basis for calculations because it was the greatest storm and flood of record in the Muskingum Basin. At that time, the heaviest rainfall was in the northern part of the Basin, extending from Bangorville (10.56 in.) to Akron (9.85 in.).[14]

Four reservoirs are provided for the Walhonding Basin, the Key reservoir, the Mohawk, fifteen miles northwest of Coshocton on the Walhonding River, having its dam where the valley narrows between a terrace on the south side and a steep cliff

[12]C. E. Sherman, *Ohio Stream Flow*, Part I, pp. 58 and 98.
R. E. Lamborn, The Newark Drainage System in Knox, Licking and Northern Fairfield Counties, *O. Jour. of Sc.*, 32: 449 (1932).
Wilbur Stout and G. F. Lamb, Physiographic Features of Southeastern Ohio, *O. Jour.* of *Sc.* 38: 71–77 (1938).
See also Zanesville, Philo, McConnelsville and Caldwell (Ohio) Quadrangles.

[13]Official Plan for the Muskingum Watershed. Conservancy District. (Revised June 5, 1935), Vol. I, p. 21.

[14]For figures and maps of the March, 1913, rainfall and flood in the Muskingum Valley, see A. H. Horton and H. J. Jackson, The Ohio River Flood of March-April, 1913. U. S. G. S. Water Supply Paper No. 334. Also, C. E. Sherman, *Ohio Water Problem*, p. 9 et seq.

on the other.[15] This dam will not form a permanent lake, its entire storage capacity of 7,950 acres being designed for flood control alone. In the January, 1937, flood, this dam, incompleted and with gates not closed, created a lake 39 feet deep. The river at normal times will flow through two large outlet tunnels through this dam, one of which penetrates the cliff of sandstone and interstratified sandstone and shale, which constitute the Mississippian formations occurring in the western third of the watershed. In the eastern two-thirds of the Muskingum basin these formations are overlaid with the Pennsylvanian formations, which average 1,100 feet in thickness. (Geol. Survey of Ohio, 4th Series, Bull. 26, p. 104.)

The Mohawk Dam is 111 feet high and 2,330 feet long. It is of earth and rock fill and is estimated to cost $2,292,763. A view from its down-stream side shows the river emerging from the twin tunnels. (Plate II, Fig. 4.) This dam was completed during the summer and fall of 1937. If the reservoir, in times of flood, is ever filled to capacity, which may never happen, it can overflow through the spillway in a saddle just to the right (north) of the cliff, which is joined to the upland by a narrow ridge.

Each dam of the Muskingum Project is provided with such an overflow spillway, and wherever possible these are located in saddles isolated from the main dam as illustrated in Fig. 5 of Plate II for the Clendening Dam. One of the outlet tunnels for the Clendening reservoir penetrates this same cliff. These outlets are constructed so as to take care of maximum capacity required under minimum head and have more than one opening as may be seen at the Wills Creek Dam. (Plate III, Fig. 6.) On the down-stream side the concrete outlet widens into a stilling basin, constructed to slow down the rushing flood waters. How this operates is apparent from the photo taken at the Mohicanville Dam January 27, 1927. (Plate III, Fig. 7.) The outlet openings, stilling basin, and spillways of the Charles Mill Dam, the first one completed, may be seen in the view looking upstream (Fig. 11). As a result of this dam some of the valley land above will be flooded by a permanent lake of 1,350 acres. A photograph taken from this dam, January 27, 1937 (Fig. 8), shows this reservoir about 6 feet deeper than the permanent lake planned. During the January, 1937, flood,

---

[15] Brinkhaven Quadrangle.

even the gates of the completed dams could not be closed because not all of the reservoir land had yet been purchased and (Fig. 12) vast volumes of the flood water rushed through with the "jump" intended by the construction of the stilling basin. All but three of the reservoirs were to have permanent lakes, varying in size from 350 to 3,550 acres. These were to be available to the public for boating, fishing and for cottage sites. Their combined shorelines total some 200 miles, or about equal to Ohio's frontage on Lake Erie. Practically all of this frontage is privately controlled. This is the case with almost all the areas around Ohio's inland lakes. Plate IV, Fig. 15, shows part of the lake at the Leesville Dam as it appeared in April, 1937, and indicates its beautiful setting. This was planned to be a permanent lake of 1,200 acres.

These lakes would occupy only the bottom parts of the reservoirs and were intended to store water for beneficial uses, the most important of which is the stream flow regulation required to provide during dry seasons the water necessary in the valleys below for domestic and industrial uses, satisfactory sanitary conditions, and maintenance of water table requirements for agriculture.

Notwithstanding the obvious advantages of these permanent lakes and their tremendous importance for water conservation and recreation, objections on the grounds of prospective taxation have arisen, particularly in Stark County. Litigation originating there has resulted in court decisions, which, unless additional funds are obtained from the State or Federal government, make improbable any immediate development of more than two or three, if any, of the proposed permanent lakes. In fact, April 29, 1938, the Director of the District announced they were restricting land purchases to the flood control program, but expressed a willingness to co-operate with any agencies interested in promoting the additional funds required for lakes and parks.

Fig. 11, Plate III, a picture of the Charles Mill Dam August, 1936, shows: the spillway, the stilling basin, and the outlets each provided with gates to maintain the water conservation level of the permanent lake, and to regulate the flow of the flood waters. Each gate is controlled from the gate house above.

Each of the fourteen dams in the District will be operated by gate keepers who will live in modern brick cottages (Fig. 10),

built by the U. S. Government as part of the construction of every dam. These tenders will operate the gates during storms or drouths, in fact at all times, according to instructions from a central office of the Conservancy District. They will also keep regular rainfall records, take stream gauge readings, etc., as part of a comprehensive schedule for the entire system.

An aerial view (Fig. 13) of Charles Mill dam shows not only the farms below, but also how advantage has been taken of the narrowing of the present valley due to a terrace on the left (east) and a hill on the right connected by a saddle of glacial drift to the west wall of the preglacial valley.[16] All but two of the reservoirs occupy valleys antedating the glacial times, whose rock floors are deeply buried by glacial material or land waste, and whose dissected interfluves give irregular shape to farm lands.

The Pleasant Hill Dam on Clear Fork of the Mohican River, five miles southwest of Loudonville, has been constructed in a relatively young rock-cut gorge amidst beautiful scenery (Fig. 14). This is evidenced by the view down stream through its steep sided and heavily wooded gorge which leads toward the Mohican State Forest.[17] The co-operation of the State Forestry Department and of fish, game, and other conservation organizations of the State promises to make the recreation facilities within the Muskingum District one of its important accomplishments.

Another dam, the Atwood, has likewise been located in a young valley, on Indian Fork of Conotton Creek, but this young part of its valley is quite short, and the reservoir will be in the preglacial valley beyond.[18] This dam was completed in July, 1937.

The other narrow, steep-walled post-glacial valley being utilized for a dam is that of the Tuscarawas River, whose Key reservoir is the only one with an all concrete dam. (Fig. 9.) This, the Dover Dam, 3½ miles northeast of the city of that name is now completed and has cost $1,618,702, including a levee to protect the historic communistic village of Zoar. The permanent lake here would be the smallest of the eleven,

[16]Perrysville Quadrangle (Ashland Co., Ohio).

[17]Clear Fork leaves its old preglacial valley some two miles above the dam site and flows south and east, probably five miles through this attractive gorge until it joins Black Fork. G. W. White, Drainage History of North Central Ohio. *O. Jour. of Sci.*, Nov., 1934, p. 379.

[18]Dover Quadrangle.

only 350 acres, but the flood reservoir capacity will be over 10,000 acres (10,100). (Plate V, Fig. 17.) Looking upstream can be seen the village of Zoarville, to be abandoned, also farms, fields, and orchards between the wood lots on the steep hillsides, the highway raised to skirt the dam on the left, and a branch of the Pennsylvania R. R. on the right. Relocating six miles of this railroad from its old route near the river's edge to a higher level is costing Uncle Sam $605,756. The seventy miles of railroad relocations in the Conservancy District are being paid for by the Federal Government, at a total cost of over $5,000,000.

(Plate V, Fig. 18.) Nine miles northwest of Dover in a mile-wide preglacial valley[19] the Beach City Dam requires a half million dollar relocation of the B. & O. R. R. from the valley to a flat surfaced terrace 30 to 35 feet high and 3,200 feet wide. Looking east and south from this dam can be seen some of the roads and fine farms to be protected below the dam.

This 4,800 feet long dam, like the Leesville Dam (Fig. 15),[20] the Senecaville Dam (Fig. 21) completed in the middle of May, 1937, in fact, like all except the Dover Dam, is of earthen construction with concrete spillways and outlets. Some rock is used for filling and, (Fig. 22) as illustrated at the Piedmont Dam, for rip-rapping the lower portion of the dam. Above this Piedmont Dam (Fig. 23), completed 1937, may be seen a portion of U. S. Highway No. 22 which would be drowned by its 2,700 acre permanent lake.[21] (Plate IV, Fig. 16.) Just below this dam can be seen nestled in the valley the village of Piedmont, which will no longer fear a flood.

At the Wills Creek Dam, too, (Plate V, Fig. 20) the highway had to be raised from the valley to the hillside on the right above the dam. At the Tappan Dam (Fig. 19), now finished, a great deal of road-filling had to be done as the new highway, State Route 250 crosses one branch of the flood reservoir. A mile above this dam the village of Tappan, entirely within the proposed lake (2,350 acres), had to be abandoned.[22] All of three villages and parts of eleven others were to be relocated or abandoned as, for example, part of Walhonding, above the

[19]Navarre Quadrangle.

[20]Scio Quadrangle (Carroll Co.).

[21]Flushing Quadrangle (Harrison Co.).

[22]Scio Quadrangle (where Willis Run enters Little Stillwater Creek).

Mohawk Dam. All such villages were given their choice of abandonment or removal to a new site.

The village of Plainfield has taken the latter choice. (Fig. 25.) Situated in a bend of Wills Creek, nearly all of the century-old town, except the school house, is below the maximum level of the flood-control reservoir. A new site above this level was purchased by the District and laid off into lots, with new streets, commons, and parks, to which the houses, stores, churches, etc., of the residents will be moved during the summer of 1938. In May, 1937, it was announced that many of the residents of Sandyville had agreed to removal and that bids would be received at the Muskingum Watershed Conservancy District's offices in New Philadelphia up to June 16 for moving the greater part of the village by December 1 to a new site half a mile northeast.[23] The remainder of the village is to be protected by a levee, as the present site will be affected by the reservoir of the Bolivar Dam on Sandy Creek.[24] Magnolia, Brewster and Zoar are other villages to receive adequate levee protection, with no moving required.[25]

The responsibility and cost of acquiring all land for such removals as well as that for acquiring the property, easements, and rights of way for the dams, reservoirs, levees, and various public utility, road, and other relocations fall upon the property owners of the District who are to receive flood control and other benefits. This total land cost has been estimated at $7,260,000, the largest amounts per county being in Tuscarawas ($1,934,570) and Coshocton ($1,058,174) Counties. The number of pieces of property listed as benefited or damaged had in 1937 reached 32,000. About 60,000 acres had already been acquired or contracted for by the District, notwithstanding delays due to litigation, etc.[26]

---

[23]The Daily Reporter, Dover, Ohio, May 18, 1937.

[24]Dover Quadrangle, Tuscarawas Co.

[25]It is reported that many residents of Zoarville now regret their decision to sell out individually and let the town be abandoned. Some of them and also certain farmers complain that their property was appraised only at present value, which is, they say, not enough for them to buy or build elsewhere on a rapidly rising market. The railroads, they say, got for their old property everything new, as ties, rails, bridges, etc., when they were relocated. Dover, Ohio, Daily Reporter, May 22, 1937.

[26]Mr. Hal Jenkins' Letter of May 3, 1937.

A proposed $1,500,000 issue of general property tax bonds was held unauthorized by the Fifth District Court of Appeals, as it was for recreation or conservation purposes, so the District is compelled for lack of funds to limit its activities to flood control. (M. W. C. D. News Release, April 29, 1938.)

The benefited properties are credited with about $14,000,000 increase in valuation, approximately twice the assessed damages. Thus the assessments on benefited property-owners would be about 50% of their increase in valuation. These assessments may be paid over a period of 30 years. Over 70% of this assessed benefit valuation is in the three river counties of Muskingum ($5,601,541), Tuscarawas ($3,049,324), and Washington ($1,211,909), in the order named.

Two million dollars has already been appropriated by the Ohio General Assembly towards the Conservancy District's share of the cost, and the Ohio State Highway Department and Federal Bureau of Public Roads are paying for all highway relocations (150 miles; estimated cost $8,804,753). The highway relocations were about 50% complete at the end of April, 1937.

The balance of the cost of this $43,000,000 project ($27,190,-000: $22,090,000 granted by P.W.A. in 1933; an additional Federal grant of $3,500,000 in 1936; and $1,600,000 in February, 1937),[27] has all been contributed by the Federal Government, which through the United States Corps of Engineers is in charge of construction of all dams and public utility relocations. The public utility relocations include 13 miles of oil lines, 75 miles of gas pipe lines, 65 miles of power lines, and 270 miles of telephone and telegraph lines.

When construction (begun January, 1935) is completed (by June, 1938, it is expected) the United States Corps of Engineers will turn the entire project over to the District for operation and perpetual maintenance. One of the tangible benefits of the project to date has been the employment furnished. The first year it reached a peak of 4,000. During 1936 it averaged 4,500 weekly, with a peak of 5,178 one week. The average 1936 pay roll was $125,000 weekly. It was, of course, lower last year, as the work was more nearly completed.

May 14, 1937, at Cambridge, the people of the Zanesville-Cambridge section of the District celebrated the dedication of the Senecaville Dam (Plate VI, Fig. 21) just completed. It is 52 feet high and nearly half a mile long and is located nine miles southeast of Cambridge on the Seneca Fork of Wills

[27]This P.W.A. grant of $1,600,000 by Executive Order of the President, according to Mr. Bryce C. Browning, Secy.-Treas. of the District, meant that they could resume land purchases and yet keep their pledge to benefited property holders that their assessments would not be over $6,000,000. Ohio State Journal, Columbus, Ohio, February 18, 1937.

Creek. Its permanent lake (Fig. 24) then covering some 1,200 acres will be the largest in the Conservancy District, 3,550 acres, while its flood reservoir capacity will be 5,170 acres. This permanent lake will be larger than Buckeye Lake and exceeded in Ohio only by Indian Lake and St. Mary's. Seneca Fork's crooked valley traverses beautifully wooded hills and when filled, the lake will extend seven miles to Batesville in Noble County.

The benefits of this conservancy project cannot be measured in dollars alone.[28] While its main purpose is flood control and its second objective is water conservation, it also has for its ultimate goal proper land utilization, soil conservation, reforestation, wild life preservation, and better opportunities for outdoor life and recreation. Already there have been established within the District three demonstration projects for the prevention of soil erosion, a large tree nursery of the Soil Conservation Service near Zanesville, and at Coshocton a big laboratory for hydrologic, soil and water studies. This project, the government officials claim, has been located here because the results of the study can readily be utilized in the work of the Muskingum Conservancy District.

There some 25 or 30 persons, mostly scientists and engineers, will study soil and water losses from the complete Muskingum Watershed. Lysimeters (water meters) and various devices have been installed to chart the rain that falls, what soaks into the ground or runs off under different conditions of cover, soil, slope, terracing, etc.; to gauge stream flow; to observe silting. In short, for the first time to carry out a project on a scale broad enough to base definite conclusions. This may take four or five years but from the facts learned, it is hoped to determine proper soil and water conservation practices.[29]

Another project now established, throughout the Muskingum Basin under the direction of Dr. C. Warren Thornthwaite, Chief of the Physiographic and Climatic Research Division of the Soil Conservation Service, promises much aid to the Conservancy District. It has set up 500 stations throughout

[28]Of the approximately $14,000,000 increase in property values originally listed as due to the District's flood control project, some $8,000,000 consisted of benefits to private and industrial property, over $2,760,000 benefits to public utility property and more than $3,200,000 of benefits to public property. *M. W. C. D. News Release* of Mar. 5, 1936. Sheet 2.

[29]Statement of Mr. W. D. Ellison, S. C. S. Hydraulic Engineer. *Columbus Dispatch*, March 21 and April 2, 1937.

the watershed where observers have taken readings at half hour intervals of rainfall, wind direction and velocity, and temperature. Daily maps covering the area will aid in the study of storms, their intensity, and their migrations. This should aid greatly in determining flood hazards.[30]

The Muskingum Project has already attracted much attention not only throughout the United States but also in Canada and in Europe. In March, 1937, nine members of the National House of Representatives flood control committee inspected the dams of the District, with a view to its possible importance as an example for other projects in the Ohio and Mississippi Valleys.[31]

Unlike the dams in the Miami Conservancy District in which the conduits are just large enough to permit sufficient water to go through to fill the stream channels below, with the excess water automatically backing up behind the dams, the Muskingum Dams, on account of the larger area and more complicated tributary system involved, will be controlled by steel gates operated by men directed from the Central Office which is in touch with all parts of the system. The conduits are larger than the channel capacities below, and as fast as the channels can accommodate the water after the passing of a flood crest one or more of the gates can be raised gradually, thus releasing water above the level of the permanent lake.

For facilitating water supply operations, seven of the dams have cast iron pipe lines imbedded in their concrete outlet works. Thus, without disturbing the structure, the District can easily connect with feeder lines, to furnish water from the permanent reservoirs for city, industrial or domestic use when needed.

During the January rains of 1937, on account of not yet owning all the necessary reservoir lands, the District could not close the gates at any of the dams, yet they automatically held back sufficient water to fill practically all of the reservoirs to permanent lake level or more, thus resulting in a lowering of flood crests from two to five feet and contributing to a lessened flood damage at critical points in the valleys below.[32] No flood

---

[30]Personal interview with Dr. Thornthwaite. Also information furnished by Mr. Hal Jenkins and Mr. Bryce C. Browning for the Amer. Forestry Association under date of Apr. 14, 1937.

[31]See *Ohio State Jour.*, Mar. 31, 1937.

[32]Estimates of C. C. Chambers, Chief Engineer for the Conservancy District. See also *Columbus Dispatch*, Jan. 24, 1937.

has come to test these great dams since the last one was finished early in February, 1938, but for flood control they are ready when the test does come.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation of the debt due to the officials of the Muskingum Watershed Conservancy District for permission and facilities to examine the works, records and plans of the District. He is particularly grateful to Mr. Hal Jenkins, Press Representative of the Conservancy District, for interviews, bulletins and official documents, as well as for photographs. To him should be credited all the aerial cuts used in this article. Thanks are also due to Mr. John Getz for the photo of the Mohawk Dam and for assistance in compiling statistics.

OFFICIAL PLAN OF RESERVOIRS*

Name of Reservoir	Stream	Drainage Area Note (A) Sq. Mi.	Elevations		Area	
			Spillway El. Line Feet	Conser. Pool, Feet	Flood Reservoir Acres	Permanent Lake Acres
Wills Creek ...	Wills Creek. .	723	779	742	11,450	900
Senecaville. ..	Seneca Fork .	121	842.5	832.2	5,170	3,550
Mohawk	Walhonding River ...	817	890	799.2	7,950	0
Pleasant Hill. .	Clear Fork. ..	199	1,065	1,020	2,600	850
Charles Mill...	Black Fork. .	216	1,020	977	6,050	1,350
Mohicanville...	Lake Fork ...	269	963	932	8,800	0
Tappan. ...	Lt. Stillwater Creek. ...	71	909	899.3	3,100	2,350
Clendening .. .	Brushy Fork	70	910.5	898	2,620	1,800
Piedmont.	Stillwater Cr..	84	924.6	913	3,200	2,270
Beach City. . .	Sugar Creek. .	300	976.5	948	6,150	420
Dover	Tuscarawas River ..	777	916	874	10,100	350
Bolivar.	Sandy Creek..	502	962	895	6,500	0
Atwood	Indian Fork.	70	941	928	2,570	1,540
Leesville. ..	McGuire Cr.	48	977.5	964	1,470	1,000
Totals ..	.. . ...	4,267	.. . ..	... .	77,730	16,380

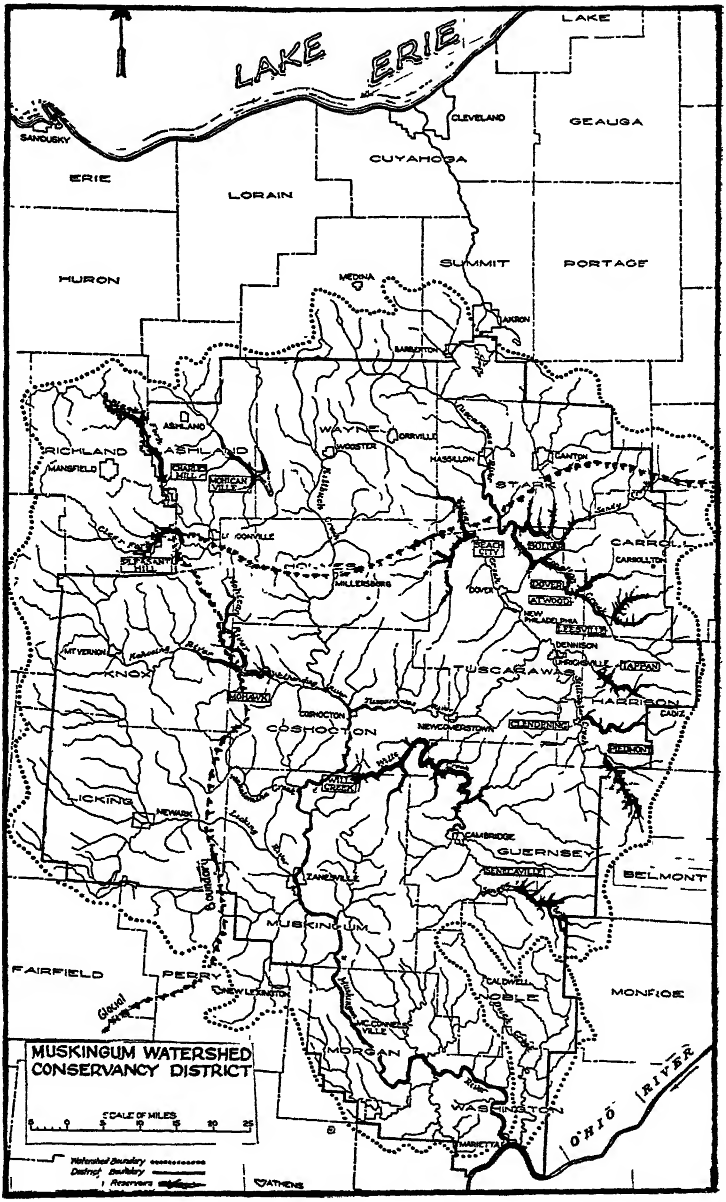
Note (A)—Less area reservoired above.

EFFECT OF OFFICIAL RESERVOIR PLAN ON MARCH, 1913, FLOOD*

Critical Point	Stream	Flood Stage, Ft.	Flood of 1913	Reduction, Feet
Walhonding River:				
Loudonville ..	Black Fork	....	.	6 0
Warsaw	Walhonding River...	. .	..	10 7
Tuscarawas River:				
Sherrodsville....	Conotton Creek....	..	...	— 1 0
Dover.	Tuscarawas River..	7.0	16.1	7 8
N. Philadelphia.	Tuscarawas River...	....	. .	7 1
Dennison	Lt. Stillwater Creek.	.	.	(a)
Uhrichsville. ...	Stillwater Creek. ...	11.0	17 3	3 8
Tuscarawas. ...	Tuscarawas River..	. .	. .	6.4
Gnadenhutten...	Tuscarawas River...	. .	. ..	6 2
Port Washington	Tuscarawas River...	. .	. ..	8 0
Newcomerstown	Tuscarawas River..	15.0	21 0	9 5
West Lafayette..	Tuscarawas River..	. ..	..	7 2
Freeport . ..	Stillwater Creek. ...	. ..	. .	4 0
Muskingum River:				
Coshocton .. .	Muskingum River...	8 0	28 8	10 6
Cambridge.	Wills Creek	...	..	3 7
Dresden..	Muskingum River ..	...		14 4
Zanesville.	Muskingum River...	33.0	51.8	15 3
McConnelsville..	Muskingum River...	15 3	35 1	14.2
Marietta..	Muskingum River...	28.0	59 8	6 3

(a) Practically same as Uhrichsville.

*Compiled from the Official Plans for the Muskingum Watershed Conservancy District, Vol. I, Revised ed. of June 5, 1935.


LAKE ERIE
LAKE
SANDUSKY
CLEVELAND
GEAUGA
CUYAHOGA
ERIE
LORAIN
SUMMIT
PORTAGE
HURON
MEDINA
AKRON
BARBERTON
ASHLAND
WAYNE
ORRVILLE
WOOSTER
RICHLAND
MANSFIELD
CHARLES MILL
MOHICAN VILLE
MASSILLON
CANTON
STARK
CARROLL
CARROLLTON
BEACH CITY
BOLIVAR
DOVER
ATWOOD
LEESVILLE
NEW PHILADELPHIA
DENNISON
UHRICHSVILLE
TAPPAN
PLEASANT HILL
HOLMES
MILLERSBURG
MT VERNON
KNOX
TUSCARAWAS
HARRISON
CADIZ
MOHAWK
COSHOCTON
NEWCOMERSTOWN
CLENDENING
PIEDMONT
WILLS CREEK
LICKING
NEWARK
CAMBRIDGE
GUERNSEY
SENECAVILLE
BELMONT
ZANESVILLE
MUSKINGUM
FAIRFIELD
PERRY
NEW LEXINGTON
CALDWELL
NOBLE
MONROE
McCONNELSVILLE
MORGAN
WASHINGTON
MARIETTA
OHIO RIVER
ATHENS
Glacial Boundary
MUSKINGUM WATERSHED
CONSERVANCY DISTRICT
SCALE OF MILES
5 0 5 10 15 20 25
Watershed Boundary
District Boundary
Reservoirs

EXPLANATION OF PLATE II

Fig. 2. Universal Potteries, Inc., South side of Cambridge (looking across Wills Creek Valley).

Fig. 3. Flood at Coshocton (looking north), August, 1935. Waterworks plant in center near bridges over Tuscarawas River. Glimpse of Walhonding at left. (These two rivers unite to form the Muskingum about a block southwest of the bridges.) Photo courtesy of Hal Jenkins.

Fig. 4. North end of Mohawk Dam (looking west upspream), Walhonding emerging from Twin tunnels. Photo by John Getz.

Fig. 5. Clendenning Spillway being cut through solid rock. (View westward into valley below. Dam is just to left of foreground.)


2.
5.
3.
4.

EXPLANATION OF PLATE III

Fig. 6. Concrete Outlets of Wills Creek Dam. Gate house under construction above outlet. (Looking north downstream at part of valley below) September, 1936.

Fig. 7. Mohicanville Dam Spillway, gate guarded outlets and flood waters flowing into basin below. (Looking north upstream) January 27, 1937.

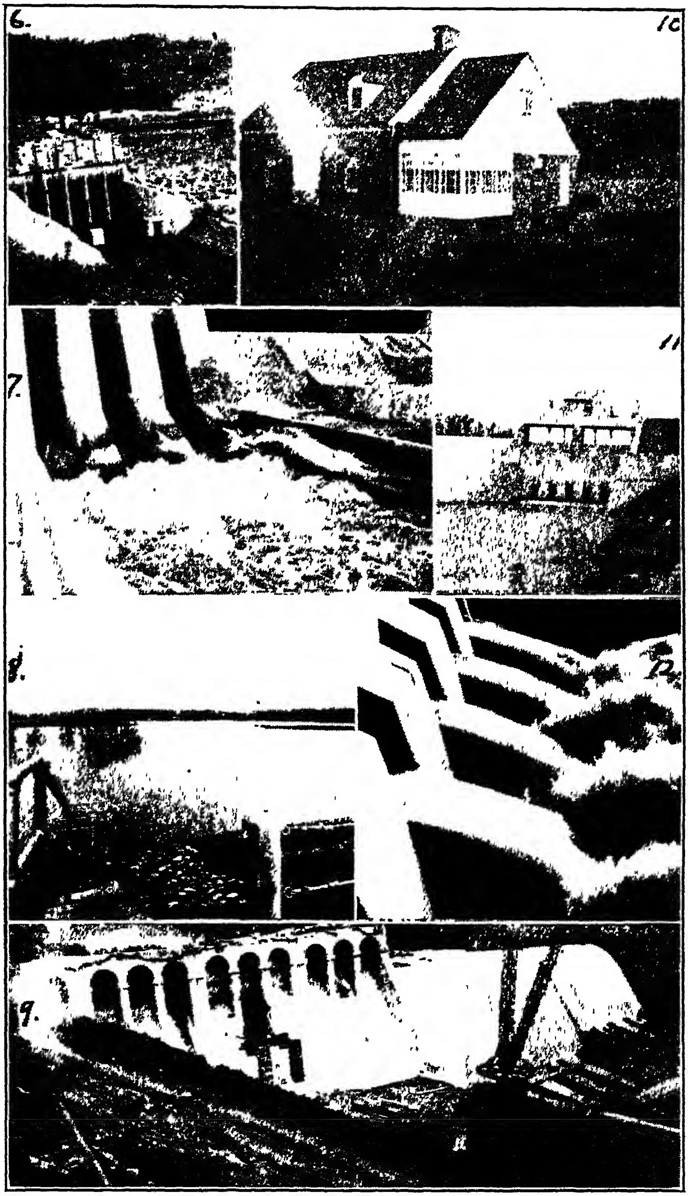
Fig. 8. Lake at Charles Mill Dam. Looking north from spillway. (Water surface about 6 feet above permanent lake surface.)

Fig. 9. Dover Dam seen from below. Outlets and stilling basin below at right. (Only west half of dam constructed then; nearly as much more to be added on the right.) Photo taken November, 1936.

Fig. 10. Gate operator's cottage, Mohicanville Dam. Part of dam visible in the background at the right. (Looking north upstream.)

Fig. 11. Charles Mill Spillway, Stilling Basin, Outlets, and Gatehouse above. (Looking upstream.)

Fig. 12. Charles Mill Dam. Outlets in action, January flood, 1937.


6.
10
7.
11
8.
12
9.

EXPLANATION OF PLATE IV

Fig. 13. Birdseye view of Charles Mill Dam and surrounding country. (Looking southwest downstream.) Note: Change in road to come around left end of dam on glacial terrace; school building in foreground to be abandoned; and spillway at foot of bed rock hill, which connects by a saddle of glacial drift to west wall of preglacial valley nearly a mile to the west.

Fig. 14. Site of Pleasant Hill Dam (looking northwest upstream). Dam 775 feet long and 113 feet high has since been constructed between the two temporary bridges, and extends from wooded cliff on left to wooded slope on right. Valley bottom here is 250 feet wide and its steep walls rise from the stream level of 964 feet to the rugged upland about 1,200 feet above sea level.

Fig. 15. Leesville Dam and part of Lake (looking west). Most of earthen dam is visible at the left, while at right above the concrete outlet works, the gate keeper's house may be seen. This photo and the two above, courtesy of Hal Jenkins, whose silhouette appears below. April, 1937.

Fig. 16. Village of Piedmont as seen from the dam. (Looking north downstream, September, 1936.)

PLATE IV

EXPLANATION OF PLATE V

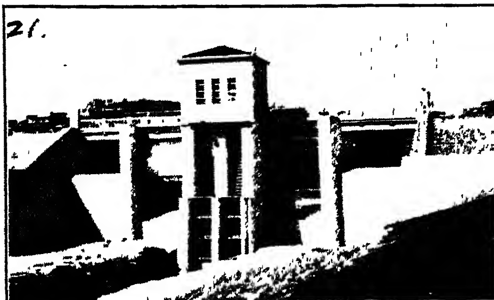
Fig. 17. Dover Dam and the Gorge of the Tuscarawas River. (Looking north and upstream to village of Zoarville, soon to be abandoned.) Note: hillside orchards and farm lands separated by wooded ravines and slopes; State route No. 8 surmounting west abutment of dam; and new track of Penna. R. R. elevated from old line at right of stream.

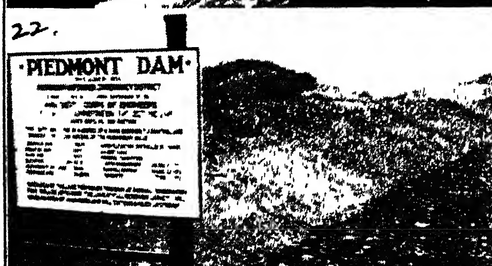
Fig. 18. View of Beach City Dam and surrounding country. (Looking southeast downstream.) Long earthen dam in center; B. & O R. R. moved from valley to terrace on left; roads and farms in mile-wide preglacial valley.

Fig. 19. Tappan Dam from above. (Looking north.) Gate house and dam have since been finished. State highway No. 250 elevated to height of north end of dam, which is 52 feet high and 1,600 feet long.

Fig. 20. Wills Creek Dam (under construction September, 1936). Looking upstream can be seen cornfield in valley at left of creek and on right close to stream, old road that had to be elevated to position above at right.


18
19.
20.





EXPLANATION OF PLATE VI

Fig. 21. Senecaville Dam (looking west to wooded slopes of valley below). Below are barred outlets whose heavy steel gates control level of permanent lake and flow of flood waters, by means of machinery operated by tender in gate house above. This dam was dedicated May 14, 1937.

Fig. 22. Piedmont Dam (lower side looking west). Below at right is part of the rock riprapping protecting lower half of the dam. Gate tender's cottage is seen at west end of dam.

Fig. 23. Piedmont Dam (looking north down U. S. Route 22, to be relocated to make way for permanent lake).

Fig. 24. Senecaville Lake (looking northeast from point near south end of dam) April, 1937. Lake then about 1,200 acres, to be increased to 3,550 acres.

THE SUPRAMARGINAL RIDGE IN CERTAIN AMERICAN SNAILS

DAVID T. JONES,
Associate Professor of Zoology, University of Utah
(on leave of absence for one year);
Assistant in Microscopical Anatomy,
Indiana University School of Medicine

INTRODUCTION

It is well known that the periostracum of mussels and clams is secreted in a groove of the mantle margin alongside a roll of high columnar cells (Jones, 1925–27, Figs. 11 and 13). Few persons, however, are aware that the periostracum of the snail shell is secreted from its mantle margin in essentially the same way, from a supramarginal groove in front of a supramarginal ridge (Jones, 1935, Plate I). In the bibliography of a previous article (Jones, 1935) are references which will lead those interested to the literature.

In Europe, Burkhardt, Roth, and others have studied the supramarginal ridge of *Helix pomatia;* Matthes, *Helix pisana;* Eckhardt, *Vitrina pellucida;* Beck, *Buliminus obscurus;* Napela, *Helix arbustorum;* not to mention the works of Longe and Mer, Moynier de Villepoix, Simroth, Zill, Biedermann, Annandale, Prashad, and others. In this same article is described the mantle of the tiger snail, now designated as *Discus alternatus* (Say), one of the very few descriptions of the mantle margin of an American snail. The present article attempts to present the comparative histology of the mantle margins of twenty-one additional species of American snails, as to the ridges and grooves in the periostracum secreting region. While such an article must necessarily be more or less superficial, the comparative view of a wide section of the field cannot but be helpful in promoting later more detailed studies. The former is beyond the immediate reach of the average graduate student, but the latter constitutes a compact, delimited problem.

Before selecting the sections to be drawn, several hundred research slides in the author's private collection were studied. Most of these are on mantles, among which are included several recently prepared serials to help solve doubtful points. European

and Asiatic specimens in this collection were disregarded, as these sections confirm drawings already available in the literature. In most cases sections of from three to eight or ten individuals have been studied. In a few cases, which are noted, sections from one specimen alone have been presented, where these seem to have been cut squarely across. Not only has variation between individuals in the same species made selection of sections difficult, but also variation of ridges and grooves within the same mantle. For example, the phase of a ridge on the columellar lip of the mantle may appear very different from the phase of the same ridge on the outer lip. Personal judgment has had to be used rather arbitrarily in the selection of good sections. In most cases one of the more complex phases was selected, because therein could be demonstrated the most of the more-frequently-occurring structures, which one comes to regard as "characteristics" for that species.

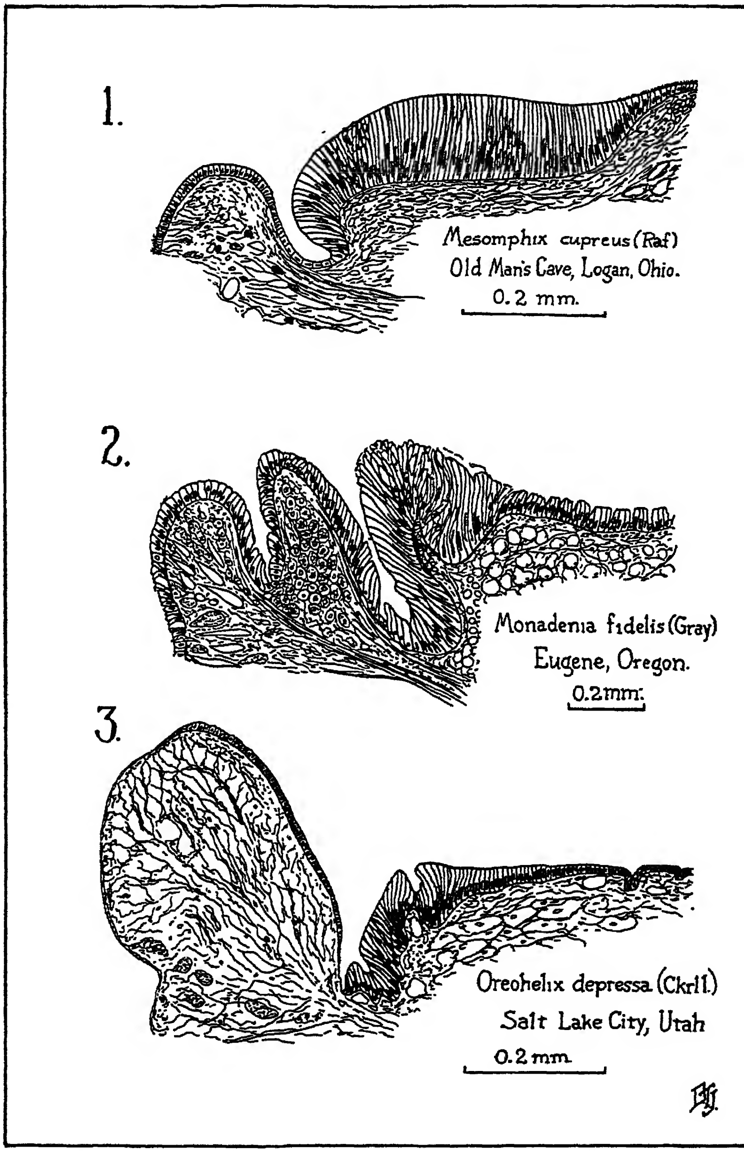
As to nomenclature, in Figure 2 the supramarginal ridge is shown as the heightened epithelium continuous with the low epithelium on the reader's right. To the left of this is the supramarginal groove, to the left of which is an "intermediate ridge," to the left of which in turn is a "secondary groove," to the left of which again is the "frontal ridge," the left margin of which is continuous with the front of the mantle. The terms in quotation marks are purely arbitrary, assigned for convenience in the following descriptions.

DESCRIPTIONS AND DISCUSSIONS OF FIGURES

Figures 1, 2 and 3 are introductory, representing the mantle edge of a large land snail from each of the three great snail regions of America respectively. Figure 1, of *Mesomphix cupreus* is of a snail commonly occurring in southern Ohio and West Virginia. It has a fragile shell covered with smooth shining periostracum. These mantles tend to show a flattened supramarginal ridge at least on the outer lip of the mantle, often extending on to the columellar lip also. Some individuals show the ridge divided into two, three, or more flaps, similar to that of another species shown in figure 14. This condition, when present, is usually more pronounced on the outer lip of the mantle.

Monadenia fidelis, the beautifully colored, heavy shelled snail of the Oregon region, has a shining periostracum. The outer edge of its mantle (fig. 2) has a double groove which usually extends over to the columellar side. Usually the secondary groove is non-secretory, but here it appears to be secretory. It is not known whether the two grooves function simultaneously. The intermediate ridge between the two grooves is of variable height. Flaps of clear epithelial cells, similar to the one shown, tend to project into the supramarginal groove

from its floor. The crest of the supramarginal ridge is often formed of sinuously curved cells, which shatter when cut.



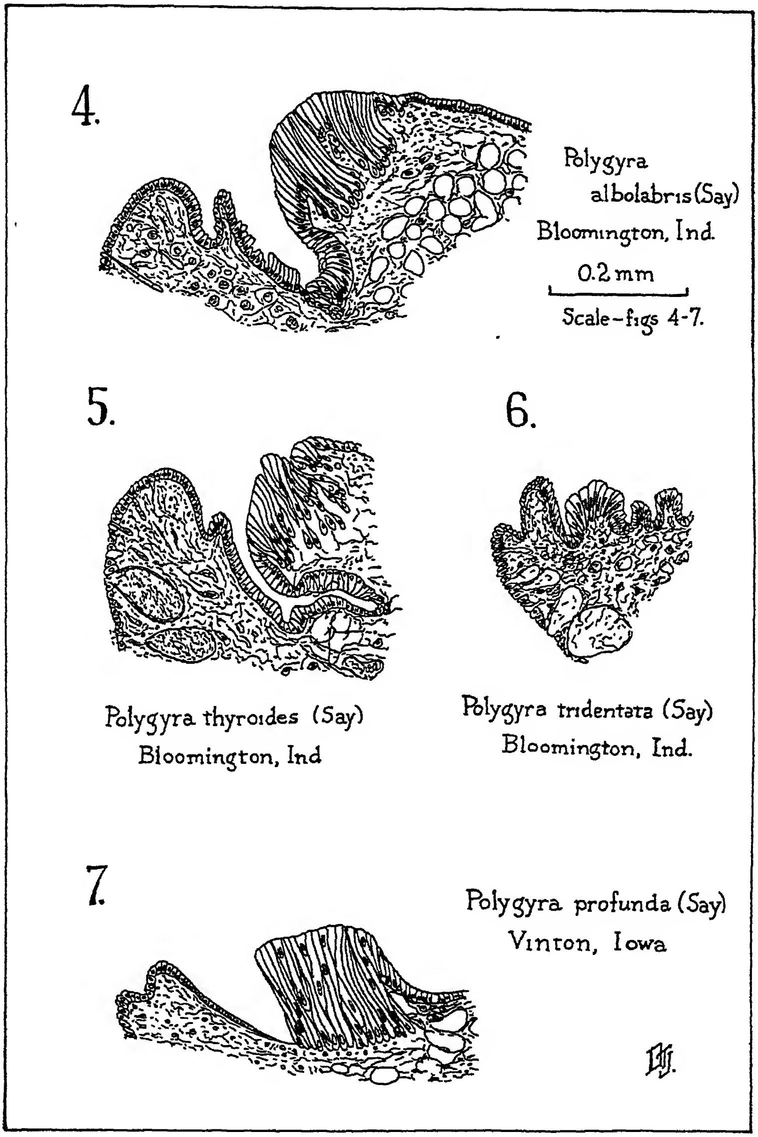
Oreohelix depressa, the widespread land snail of the Great Basin, has a heavy, irregularly-ribbed shell, which has very little periostracum in the mature specimens. The supramarginal ridge and groove are

very variable. On the outer lip of the mantle, the former may be as complex as that shown (fig. 3). An unusual situation is occasionally found, where large unicellular mucous cells empty into the supramarginal groove. There is a tendency for the supramarginal ridge to be divided into flap-like groups of cells. The mantle margin does not greatly resemble that of most of the groups of large land snails. Some of the above features arouse suspicion that the supramarginal ridge may involute to some degree after shell maturity has been reached, though our present material is insufficient to so conclude.

Many of the *Polygyra* examined (figs. 4 and 5) show a basal grouping of the tall cells of the supramarginal ridge. Such has been reported, not only in European Helices, but also in certain of the Viviparidae (aquatic) by Prashad. It appears as a downgrowth from the ridge of groups of epithelial cells into the connective tissue beneath. The supramarginal ridge (but not the intermediate ridge) is usually obsolete on the columellar side of the mantle. This is a very confusing situation to analyze until the continuity of the ridges can be traced in serials. The supramarginal groove sometimes has a pocket-like cleft, not always continuous in the floor, as shown in figure 5. It is difficult, even with a number of slides, to know whether to interpret these as pockets in the floor of the groove, or as twisted sections of the groove recut. The intermediate ridge, varying in size and shape, is usually present, and with the groove usually continues onto the columellar side of the mantle.

In my material, *Polygyra albolabris* (fig. 4) shows little difference between individuals. *Polygyra thyroides* (fig. 5) is essentially of the same plan as *albolabris*. However, in *Polygyra tridentata* (fig. 6) the mantle edge exhibits a barely-differentiated supramarginal ridge, though the intermediate ridge is prominent. Scant material of *Polygyra monodon* (Rackett), not figured, shows even less differentiation. Slides of *Polygyra profunda* show considerable individual variation, ranging from the type figured (fig. 7) to one showing an obsolete supramarginal ridge, but with a more pronounced intermediate ridge. European workers have suggested in such cases that the supramarginal ridge may disappear after the shell reaches maturity. (Sexual maturity is attained in most snails long before shell maturity, the latter marking that stage when additions to the shell cease.) Unfigured material of *Polygyra elevata* (Say) shows a condition intermediate between the figures of *P. thyroides* (fig. 5) and *P. profunda* (fig. 7), but with high columnar epithelium on both slopes of the supramarginal groove, also with the supramarginal ridge merging more gradually with the epithelium beneath the shell. *Polygyra palliata* (Say) (mantle figured by Jones, 1937, fig. 5r), is also of special interest, because of the evenly-arranged, hair-like spines of periostracum covering its shell. Where and how these are formed are as yet unexplained. One European malacologist, working with a pilose shell, advanced the hasty conclusion that the "hairs" were pressed into shape as the horny periostracal material was pressed between the two slopes of the supramarginal groove as it was emerging, a semiliquid mass. This explanation, however, could hardly apply, as smooth shells have as pronounced similar mantle structures. In *P. palliata* there is the possibility of

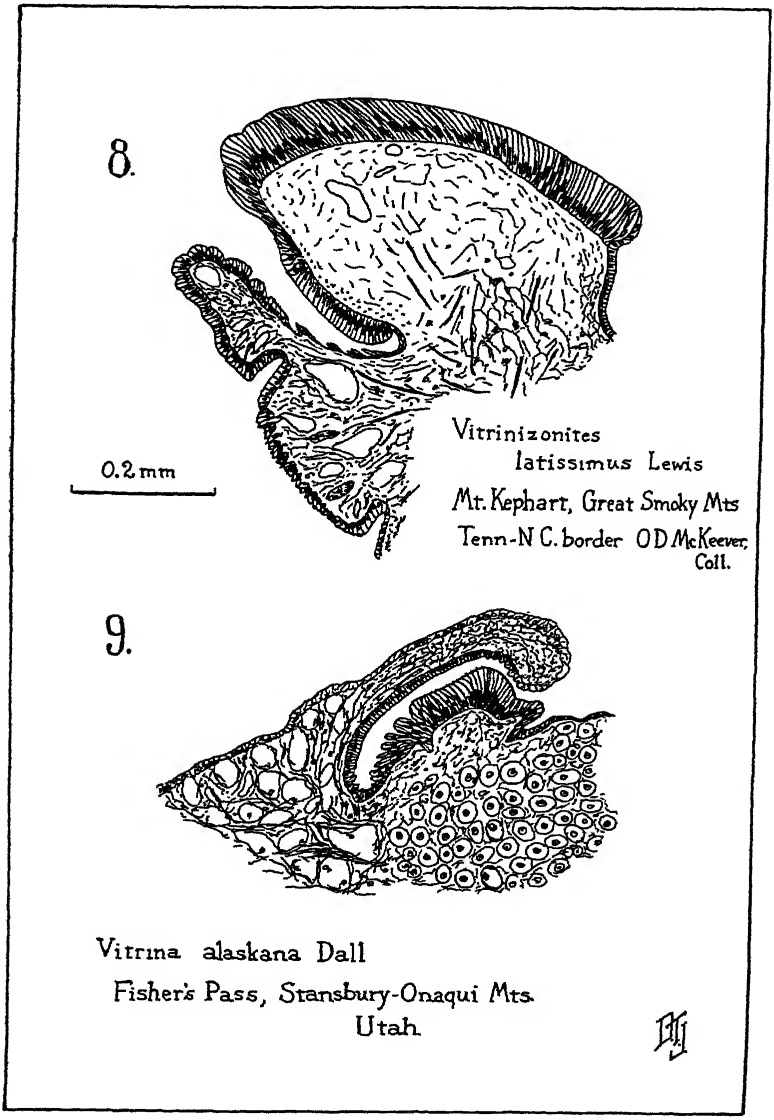
either a groove modification or a deep pocket in the bottom of the groove; my material admits of ambiguous interpretation. Clear



cut sections of *Polygyra appressa* (Say) were not drawn, as they were so nearly like the figure shown for *P. thyroides* (fig. 5).

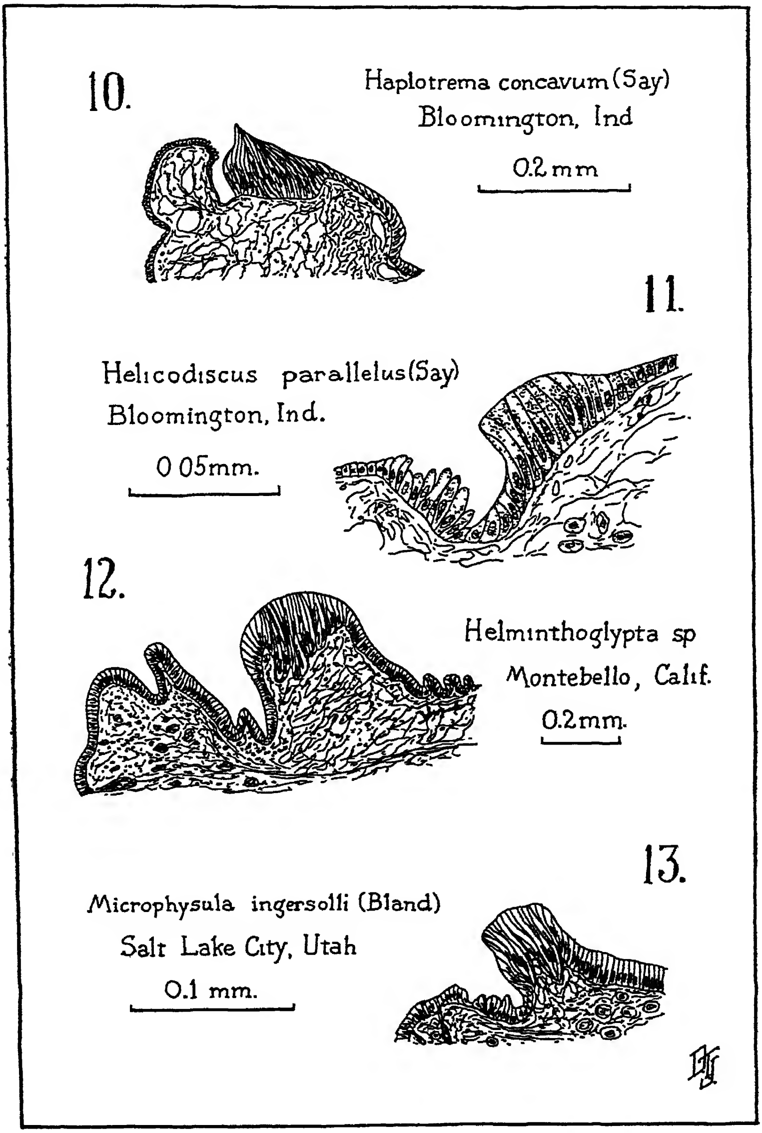
Eckhardt's bizarre figures of the mantle of *Vitrina pellucida* from the Alps, aroused curiosity as to our species of *Vitrina*. I have been

unable to secure live specimens of our eastern *Vitrina*, but the western *alaskana* shows equally as bizarre patterns, one of which is drawn (fig. 9). Here the frontal ridge sometimes arches over the much-



lobulated supramarginal ridge, in a way such as to suggest the manipulating or shaping of the fragile membranous shell, which often has so little calcareous backing that it collapses when touched. On

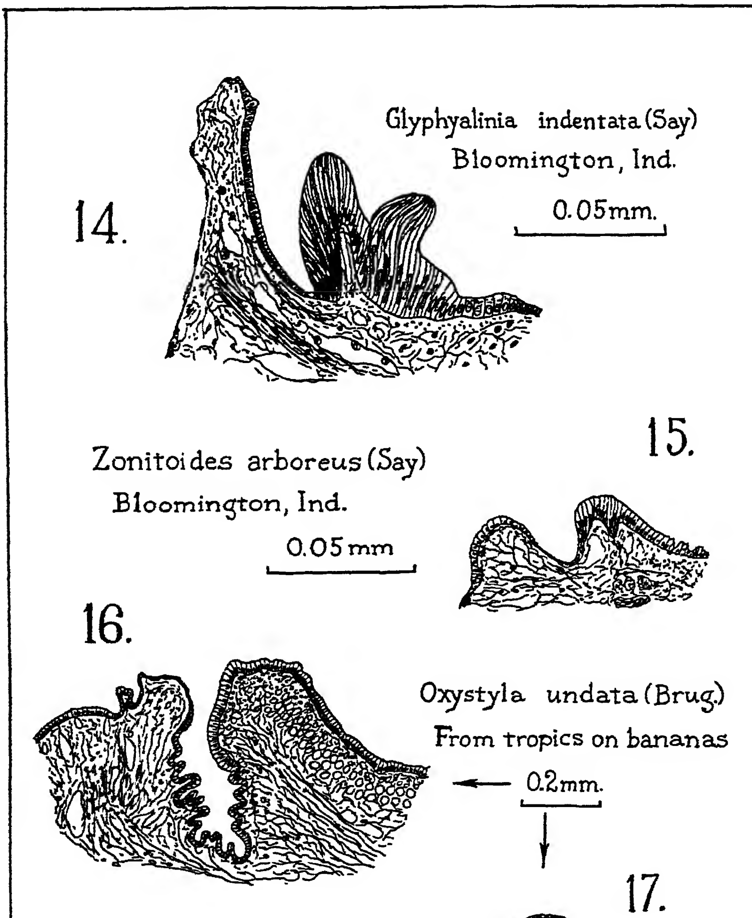
this side of the Atlantic, we are fortunate in having a queer giant vitrinoid, *Vitrinizonites latissimus*, supposedly a mutant glacial relict, now isolated in the Great Smoky Mountains. Of those which O. D.



McKeever attempted to send me, only one came through alive. From sections of this, I have drawn the queer mantle margin shown in figure 9, which shows many *Vitrina* modifications. When investigated more

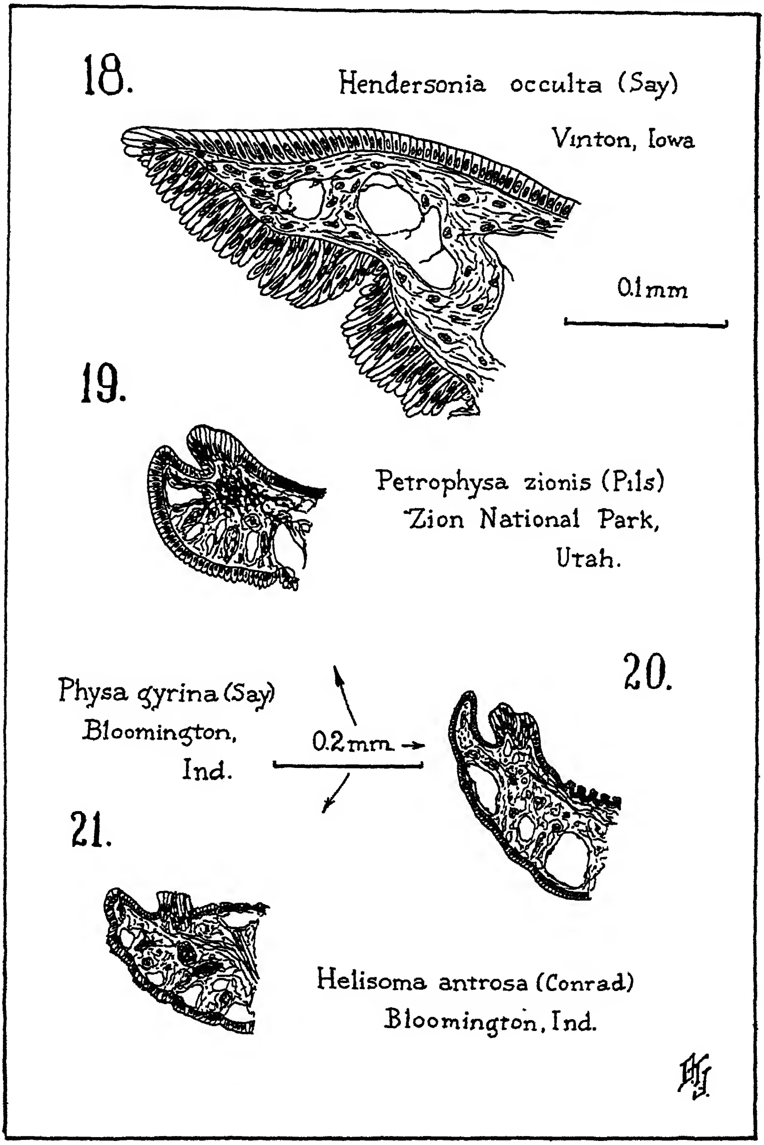
thoroughly, it may show as much variation within one mantle as is shown by the western *Vitrina.*

Haplotrema concavum, the only eastern representative of this green-



shelled, carnivorous genus, exhibits a pattern (fig. 10) quite its own. The ridge is usually sharp-pointed, and is composed of long cells twisted out of one plane, which generally causes the ridge to break when sec-

tioned. *Helminthoglypta*, probably *tudicatula* (Binney), is the only one of that genus of large California land snails examined (fig. 12). Note its similarity to *Polygyra* (figures 4 and 5), also to *Monadenia*



(fig. 2). In other specimens this *Helminthoglypta* shows a more prominent intermediate ridge than the one figured, which separates off a distinct secondary groove that may be secretory as in *Monadenia*.

In some specimens both grooves are present on both inner (columellar) and outer lips of the mantle.

Among the small snails the endodont, *Helicodiscus parallelus* (fig. 11) exhibits a clear-cut, but extremely simple supramarginal ridge and groove, usually only on the outer lip of its mantle. *Microphysula ingersolli* (fig. 13), a small Utah helicid, shows more complex tendencies toward the helicid structure of *Polygyra*. Sections of only one specimen of pupillid, *Gastrocoptera armifera* (Say), unfigured, show a short supramarginal ridge approximately five cells in length. The ridge is less sharply defined than in *Microphysula*, and the groove is barely differentiated. The mantle of *Zonitoides arboreus* (fig. 15) shows a structure simpler than that of the helicids, tending, with great variation, as much perhaps in that direction, as toward the glassy snails, with which it is commonly allied systematically. As has been mentioned, another large zonitoid, *Mesophix cupreus* (fig. 1) tends even more strongly toward *Vitrea* than the figure shows. The only one of the ordinary glassy snails (*Vitrea*) examined was *Glyphyalinia indentata*. It shows a very variable supramarginal ridge, which may be split as shown (fig. 14). Cells just back of the supramarginal ridge show golden granules in the Golgi region. Of course, *Vitrina* (fig. 9) and *Vitrinizonites* (fig. 8) are considered closely allied to *Vitrea*, but as shown their mantle margins are much more highly differentiated.

Of Neotropic land snails, I have examined only two, the *Oxystyla* that seals itself on bananas and is thus imported to our northern states, and several specimens of *Bulimulus serperastrus* (fig. 17) shipped alive to me by O. D. McKeever. The former (fig. 16), a single specimen, shows no heightening of the epithelium over a connective-tissue ridge. The supramarginal groove is well developed.

In this survey the simplest ridge found was that of *Helicodiscus parallelus* (fig. 11). However, one land snail, *Hendersonia occulata* is reputed to be far more primitive (H. B. Baker, 1925). As it is found only in isolated patches in widely scattered regions, it is not readily accessible. However, I had previously found it in the vicinity of Vinton, Iowa (Jones, 1930, also 1931). From this locality mantles were first secured which showed no supramarginal ridge or groove. Dubious of these observations, some years later, several whole animals were secured and sectioned serially. While some of these sections were not cut in the right direction for the study of these parts, a few were. Careful study of these reveals no ridge or groove, either on the outer mantle (fig. 18) or on the inner strap-like mantle. It is possible that the simplicity in this mantle may not be correlated with its primitiveness, but with the fact that the shell is practically devoid of periostracum when fully developed.

Another primitive mollusk described by Pilsbry (1925), *Petrophysa zionis*, lives on the vertical walls of Zion National Park, where water trickles over the cliff. Last year, Perry Plummer brought several back to Salt Lake City alive, but most did not fix well. However, a few show on the outer lip (fig. 19), and also to some extent on the inner, a ridge and a groove, not much different from that of the eastern pond snail, *Physa gyrina* (fig. 20). The *Physa* mantle has much epithelial

pigment in the region back of the supramarginal ridge. Subepithelial pigment may also be present. The only other mantle of a native aquatic snail observed has been that of the planorbid, *Helisoma antrosa* (fig. 21).

In conclusion, may it be re-emphasized that the limits of variation of mantle ridges and grooves should be intensively studied for each snail, both within single mantles, and between different individuals of the same species. Little is known at present of the correlation between mantle structures and the shell. Mantle ridges and grooves may serve other functions than merely secreting the periostracum, as shaping the drying periostracum, clasping and protecting the recently-formed edges of the shell, stiffening the mantle edge for support of such membranous shells as that of *Vitrina*, or closing the space between the deeper mantle and the shell, not only for protection but also to conserve shell-forming liquids. Most digitations of the mantle arise from the front of the mantle rather than from the mantle margin, where the above-described ridges and grooves are located.

BIBLIOGRAPHY

Baker, H. Burrington. 1925. Anatomy of Hendersonia: A Primitive Helicinid Mollusk. Proc. Acad. Nat. Sci. Phila., Vol. 77, pp. 273–303. Pls. 7–10.

Jones, David T. 1925–27. A Study of *Tritogonia tuberculata*, the Pistol Grip Mussel. U. of Iowa Studies in Nat. Hist., Vol. 11, pp. 3–16.

1930. Notes Taken in the Vicinity of Vinton, Iowa. Naut., Vol. 43, pp. 118–119.

1931. Red Cedar River Collections (Iowa). Naut., Vol. 44, pp. 87–91.

1935. The Formation of Shell in the Tiger Snail. J. Morph., Vol. 57, pp. 547–569.

1937. A Comparative Study of Certain Goblet Cells. Bull. U. of Utah, Biol. Series, Vol. 27, pp. 3–15.

Pilsbry, H. A. 1925. A Fresh-water Snail, *Physa zionis*, Living under Unusual Conditions. Proc. Acad. Nat. Sci. Phila., Vol. 77, pp. 325–328. Pl. 11.

Variable Stars

This little book tells the story of stars which fluctuate in brightness. The author is one of the best of the Mt. Wilson astronomers and the story, unpretentiously told, is on the whole to his credit.

The opening chapter, done in question and answer style intended to engage the reader, is inclined to suggest instead that the author is a little nervous in getting started. Once the first uneasiness is passed, however, the story is admirably told.

The chapter on the history and cataloging of variable stars is particularly interesting in that it gives an excellent idea of the typical early childhood of an astronomical problem. The rest of the book is largely explanatory of the physical conditions prevailing in such stars. The only disappointing feature of the book is the very inadequate chapter of Novae, those stars which occasionally burst forth with approximately a million times their normal brightness.

The book is written for those people who have an interest in and an elementary knowledge of astronomical phenomena.—*C. E. Hesthal.*

The Nature of Variable Stars, by Paul W. Merrill. 134 pp. New York, The Macmillan Company, 1938. $2.00.

SPIDERS AND INSECTS FOUND ASSOCIATED WITH SWEET CORN WITH NOTES ON THE FOOD AND HABITS OF SOME SPECIES*

I. Arachnida and Coleoptera

RAY THOMAS EVERLY,
Holmesville, Ohio

During June, July and August, 1935, while engaged on some field work with the European Corn Borer Research at Toledo, Ohio, opportunity was presented to make a cursory collection of the spiders and insects found upon the corn plants, or upon the ground in the corn field.

The field in which the collections and observations were made was planted to sweet corn and contained approximately four acres. During the latter part of June, July and the early part of August, series of plants, scattered over the entire field, were examined daily. This factor contributes largely to the extensive and diverse numbers of species and makes the collections representative of the entire population.

The following list does not in anyway attempt to portray a complete picture of the Arthropod population of the corn field, but rather merely indicates the tremendous number of species present in a limited area during a limited season. However, the field where this collection was made can not be considered as a normal habitat, as it was part of the European Corn Borer Research Plots and of necessity was treated much differently than an ordinary field of sweet corn. In addition to the usual cultivation operations, the plants were subjected to almost constant disturbance, due to examinations for egg masses, tasselling and silking, and population dissections. Very few extraneous plants were present in the field as in addition to the horse cultivation, the plots were hoed several times, and any weeds found during the examinations of the corn plants were destroyed. Several other factors tended to operate in reducing the number of species collected in this particular case. The collections were made incidental to the routine work or after working hours and it was impossible to pursue specimens any

*The families under each order, the genera under each family, and the species of each genus are listed alphabetically. This facilitates the locating of any desired species by those unfamiliar with a phylogenetic arrangement.

distance. In addition bulky collecting equipment such as nets, boxes, etc., could not be carried. All specimens were taken either in small vials moistened with alcohol or in small cyanide bottles. Due to this fact many of the more delicate specimens were injured and could not be determined to species. Therefore it can be safely assumed that a collection made with proper equipment in a randomly selected corn field would yield far more species.

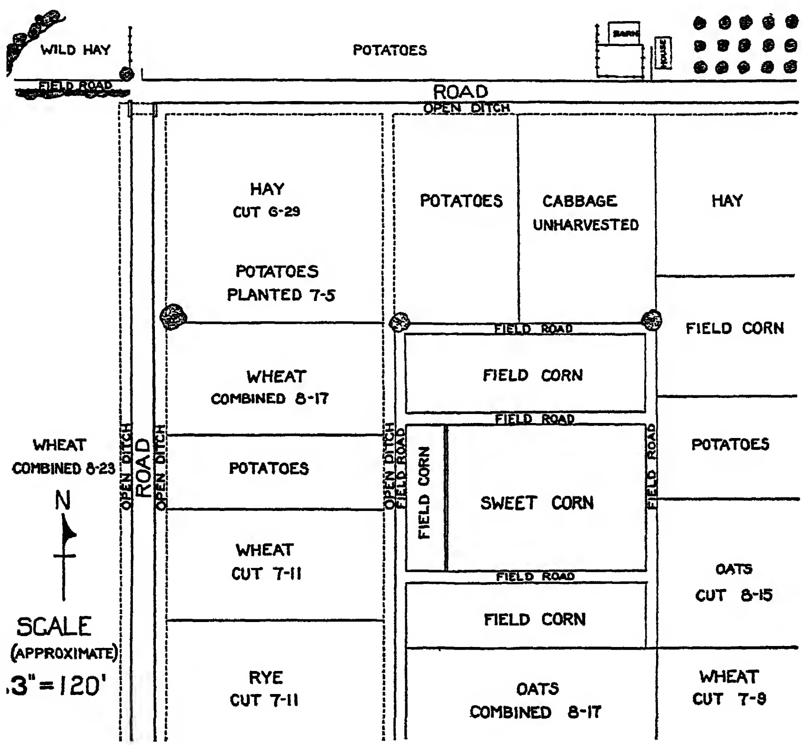


FIG. 1

This field of sweet corn was located just north of Maumee, Ohio, in Lucas County. The plots were surrounded by farmland of the intensive cultivation type, there being very few fence rows and little woodland. In the accompanying plan it will be noted that the only near place for hibernation and growth of extraneous plants were in the deep drainage ditches common to this section of Ohio. To the northwest of the field, approximately half a mile, was a small stream with rather heavily

wooded banks. Three oak trees grew within a few hundred yards of the field, and to the northeast of the field was a small apple orchard. Southwest of the field, approximately three hundred yards, was another older orchard and the farm buildings (see figure 1).

Extraneous plants found most commonly in the vicinity of the corn field were in the drainage ditch which ran along the west side of the field. The more common plants in this ditch were Canada Thistle (*Cirsium arvense* (*L.*)), dogbane or Indian Hemp (*Apocynum cannabium L.*), smartweed (*Persicaria sp.*), wild lettuce (*Lactuca sp.*), burdock (*Arctium minus Schk.*), several species of mints (*Mentha sp.*), teasel (*Dipsacus sylvestris Huds.*), white sweet clover (*Melilotus alba Desv.*), and yellow sweet clover (*M. officinalis* (*L.*)), many species of grasses (*Poa sp.*), butterfly weed (*Asclepias tuberosa L.*), bindweed (*Convolvolus sp.*), alfalfa (*Medicago sativa L.*), sour grass (*Oxalis sp.*), blue elderberry (*Sambucus canadensis L.*), poison ivy (*Toxicodendron radicans* (*L.*)), hackberry (*Celtis occidentalis L.*), wild rose (*Rosa sp.*), wild grape (*Vitis sp.*), and willow (*Salix sp.*). These wild plants and cultivated plants in the surrounding fields may account for many of the casual visitants taken upon the corn. In the corn field itself, dogbane, milkweed (*Asclepias syrica L.*), black nightshade (*Solanum nigrum Nutt.*), and smartweed were most common, especially in the roadways of the plots in the late summer.

Assistance is hereby acknowledged to Mr. Morris Schlosberg and Mr. Ralph Mathes for specimens and some observations, and to Mrs. Laura W. Everly for mounting and labeling the specimens, for aid in the determinations of the Carabidae and for assistance with the manuscript. Particular thanks are due to Mr. C. F. W. Muesebeck of the Bureau of Entomology and Plant Quarantine for granting the facilities of his staff of specialists in the determinations of the bulk of the species. Credit for determinations are given under the respective families.

ARACHNIDA

The Arachnida are perhaps more representative of the population found in the cornfield than the insects as means of escaping capture were more limited. The jumping spiders and the crab spiders were abundant throughout the season. During the latter part of August the web spinning spiders were most

numerous, particularly *Tetragnatha laboriosa Htz.* The irregular webs of this species were to be found on practically every corn plant and individuals were commonly observed mating in the webs. The following list gives the species taken. Determinations were made by Professor W. M. Barrows.

Agelenidae

Agelena sp.? (young)—Taken July 31.

Argiopidae

Aranea sp.? (young)—Two specimens taken July 8 and 9.
Aranea (see Epeira).
Argiope aurantia Lucas—Taken August 7.
Epeira or Aranea thaddeus Hentz (young)—Taken July 11.
Eustala anastera (McCook)—Male taken July 15.
Mangora gibberosa Hentz—Two females, one male and a young specmen taken July 17 to August 9.
Metargiope trifasciata Forskal—Two females taken August 9 to 15.
Neoscona arabesca Walckenaer—Female taken July 30.
Neoscona pratensis (Hentz)—Male taken August 7. This is the first record for this species in the state.
Tetragnatha laboriosa Hentz—First specimens taken July 8. Common during August. One specimen taken as the prey of a young *Phidippus* sp. (Family Attidae) taken July 31.

Clubionidae

Castianeira descripta Hentz—Two females taken on July 28.
Clubionidae sp.—Two specimens taken July 25 and August 1, which could be determined only to family.

Attidae

Attidae sp.—Four immature specimens taken July 18 to August 3.
Derrdyphrantes capitatus Em.—Three males taken July 17 to August 5.
Icius sp.—One specimen taken July 18, too poorly preserved for determination.
Phidippus sp.—Two young specimens taken July 31 and August 1. (See *Family Argiopidae, Tetragnatha laboriosa* Hentz.)
Phidippus insolens Hentz—Four males taken July 21 to August 2.
Phidippus sp.—Maybe *multiformis* of McCook female taken July 23.

Dictynidae

Dictyna sp.—One female specimen taken late in August.
Dictyna longispina Em.—One male and one female taken on July 10.

Linyphiidae

Bathyphantes sp.?—Close to *albomaculatus* Bks. taken July 9.
Ceraticelus formosus Banks—One male taken July 10.

Lycosidae

Lycosidae sp.—Immature specimen taken July 10.
Lycosa erratica Hentz—Female taken under corn debris on ground July 6.

Theridiidae

Theridium differens Em.—One male taken July 18.

Thomisidae

Coriarachne versicolor Keyserling—Female taken July 8.
Misumena sp.—Two young specimens taken July 11 and August 1.
Misumessus sp.—Probably *asperatus* Hentz young, taken August 7.
Tibellus oblongus (Walck.)—Taken July 24.
Thanatus sp.—Probably *lycosides* Em. young, taken August 5.
Thomisidae sp.—Too young for determination, taken August 5.
Xysticus sp.—Two immature specimens taken August 2 and 5.

INSECTA

COLEOPTERA

Anthicidae

This family occurred in fairly abundant numbers both on the corn plants and under corn debris about the field. Determinations were made by Mr. J. N. Knull and Mr. H. S. Barber.

Anthicus cervinus Laf.—Three specimens taken June 25, July 18, and August 2.
Anthicus (Lappus) obscurus Laf.—One specimen taken July 9.
Anthicus sp.—One specimen taken July 25.
Lappus (see *Anthicus*).
Notoxus anchora Hentz—Three specimens taken June 24 to 28.
Notoxus monodon Fab.—Five specimens taken June 26 to July 14.

Cantharidae

This family was not so abundant as some of the others. Determinations were made by Mr. H. S. Barber.

Cantharis carolina F.—One specimen taken July 13.
Cantharis sp. (immature)—One specimen taken July 15.
Podabris tomentosus Say—Very common in the field and upon the corn plants. Three specimens taken July 5 to 11.
Silis latilobus Blatch.—One female taken late August.

Carabidae

The family of Ground beetles was very abundant both on the plants as well as on the surface of the ground about the plants. Many were taken under corn and weed debris on the ground. Determinations were made by Mrs. L. W. Everly and R. T. Everly. Professor W. C. Stehr reviewed the Harpalini and his corrections are incorporated herein.

Abacidus sculptilis (Lec.)—One specimen taken June 24 under debris.
Agonoderus comma Fab.—Eleven specimens taken June 26 to August 2.

This species was abundant throughout the field, usually occurring under debris.

Amara fallax Lec.—One specimen taken June 27.

Amara polita Lec.—One specimen taken July 5 under debris.

Anadaptus baltimorensis (Say)—One specimen taken July 25.

Anisotarsus terminatus (Say)—Twenty-two specimens taken June 27 to July 28.

This species was quite common under debris of weeds and corn about the edge of the field.

Anisotarsus sayi Blatch.—Two specimens taken July 5.

Bemidion constrictum Lec.—Four specimens taken August 5 to 14 under debris where ground was moist.

Bembidion quadrimaculatum L.—Forty-nine specimens taken June 24 to late August.

This species was abundant throughout the season, especially after rains when the ground was still moist. Also taken on moist soil under corn and weed debris.

Blechrus glabratus Duft.—Forty-five specimens taken June 24 to August 9.

Very abundant throughout the field about the base of the plants and under moist debris. This genus was the most abundant of the Carabidae observed in the field.

Blechrus pusio Lec.—Fifty-nine specimens taken June 24 to August 14 in the same habitat as *B. glabratus.*

Bradytus exarata (Dej.)—Two specimens taken June 27, 28.

Bradytus apricarius (Payk.)—Two specimens taken July 5, under debris.

Casnonia pennsylvanica L.—Four specimens taken August 5 to late August. Not abundant, occurring under debris.

Chlaenius tomentosus Say—One specimen taken August 5, crawling on the roadway of the plot.

Clivina bipustulata Fab.—Two specimens taken August 7 and 12.

This species occurred under debris. One individual was very light colored.

Clivina ferrea Lec.—Four specimens taken June 29 to August 5. Agrees with key and description but much lighter in coloration. Found under debris in association with *Clivinia impressifrons.*

Clivina impressifrons Lec.—Twelve specimens taken June 27 to August 7.

Very common under debris when ground was slightly moist.

Curtonotus pennsylvanicus (Hayw.)—One specimen taken June 28.

Eumolops furtiva (Lec.)—Three specimens taken June 27 to late August under debris.

Galerita janus Fabr.—One specimen taken August 2.

Harpalus caliginosus Fab.—Six specimens taken July 8 to August 7.

This species was quite abundant under debris in the field. Generally found in burrows about three to three and one-half inches deep, at an angle of approximately 45 degrees to the surface of the soil. Two of the above specimens were much smaller but agreed with the descriptions in other respects.

Harpalus compar Lec.—Two specimens taken June 25 to July 5 under debris.

Harpalus erraticus Say—One specimen taken June 28.
Harpalus herbivagus Say—Six specimens taken June 27 to late August. Quite variable in size and for the most part taken under moist debris.
Harpalus pennsylvanicus DeG.—Nine specimens taken July 5 to August 5. Quite common under debris.
Harpalus longicollis Lec.—One specimen taken August 5 under debris.
Harpalus erythropus Dej.—Twelve specimens taken June 25 to July 19. Common under debris.
Harpalus viridiaeneus Beauv.—Three specimens taken June 27 to late August, under weed and corn debris.
Lebia bivittata Fab.—Nine specimens taken June 25 to late August.

This species generally occurred on the ground at the base of the plants or under moist debris. Several specimens were observed upon the leaves of the corn plants.

Lebia scalpularis Dej.—Eleven specimens taken June 26 to August 2. Generally found under debris or around base of corn plants.
Lebia viridis Say—One specimen, bright blue in color, taken on leaf of corn plant.
Poecilus chalcites Say—Twenty-four specimens taken June 25 to August 5, very abundant under debris and running on surface of ground.
Poecilus lucublandus Say—One specimen taken July 30, under debris.
Platynus placidus Say—Fourteen specimens taken August 1 to late August. Found under moist debris, generally after rains.
Scarites substriatus Hald.—One specimen taken August 5.
Scarites subterraneus Fab.—One specimen taken June 28.

Both of the above species occurred fairly common throughout the season under moist debris.

Stenolophus conjunctus Say—One specimen taken July 5 under debris.
Stenolophus humidus Ham.—One specimen, a female taken, June 28, under debris.

This specimen had been placed as a *conjunctus*, but Professor Stehr called my attention to the fact that the scutellar striae were practically obsolete and the striation of the elytra is very different from *conjunctus*.

Tachys incurvus Say—Twenty-seven specimens taken June 25 to August 5. Very common on moist soil after rains and under moist weeds and corn debris. One pair taken mating on August 5.

Tetragonoderus fasciatus Hald.—One hundred forty-one specimens taken June 24 to August 7. A very abundant species.

This species was observed not only under debris but actively running over the surface of the soil among the plants. One specimen was observed feeding upon the leaves of black nightshade *Solanum nigrum* Nutt., on July 22. This specimen, while under observation, ate a small circular hole through the leaf. The light sandy soil of the field undoubtedly accounts for the abundance of the species, as previously *T. fasciatus* has been taken only in sandy locations.

Tachistodes partarius (Say)—Two specimens taken under debris on June 28.

Triplectrus rusticus (Say)—Thirteen specimens taken June 27 to August 12, quite common in field under debris.

Cerambycidae

This family was abundant upon the milkweed which grew in the cornfield late in the summer. Determinations were made by Mr. W. S. Fisher.

Parandra brunnea Fabr.—One specimen taken under corn debris upon the ground August 7.

Tetraopes tetrophthalmus (Forst.)—This species was common upon milkweed in the field. Frequently seen upon the corn plants. Two specimens taken July 14 and 21.

Chrysomelidae

One of the most abundant families in the field. Determinations were made by Mr. J. N. Knull, and Mr. H. S. Barber.

Altica sp.—One specimen taken July 30.

Chaetocnema denticulata (Ill.)—One specimen taken July 23.

Chaetocnema pulicaria Melsh.—Fairly abundant upon the corn plants. Fifteen specimens taken July 9 to August 7.

Chaetocnema sp.—Three specimens taken July 18.

Chrysomela interrupta Auct.—Two specimens taken July 5 to 8.

Chrysomela obsoleta scriptoides Schaeff.—One specimen taken July 5.

Chrysopus auratus Fab.—Three specimens taken July 6 to 8. One specimen was very dark and with a bluish cast to elytra, probably immature. This species was very abundant upon dogbane growing in isolated spots among the corn plants. Specimens were frequently observed upon the corn leaves although never feeding.

Cryptocephalus quadruplex Newm.—One specimen taken July 5.

Diabrotica duodecimpunctata (F.)—Four specimens taken July 8 to August 7.

This species was very abundant. On July 7 an adult was observed feeding upon the anthers of wild rose, growing along the drainage ditch. On July 24 an adult specimen was seen feeding upon the new silk of an ear of sweet corn. It had evidently cut through about one-third of the silks when observed.

Diabrotica longicornis (Say)—This species was not nearly as abundant as the above and occurred much later in the season. Three specimens taken August 2 to late August.

Disonycha triangularis (Say)—This species was very abundant on black nightshade. Taken quite frequently on corn leaves. Three specimens taken July 9 to 13.

Epitrix cucumeris Harris—This species was very abundant upon the corn plants. Two specimens taken July 28 to 30.

Gastroidea polygoni (L.)—One specimen taken July 18.

Glyptina abbreviata Gentn.?—Three specimens taken July 11 to 19.

Lema lecontei Clark?—Very abundant upon black nightshade growing in roadways of plots. Specimens taken upon corn leaves of plants adjoining areas of nighshade. Pair taken mating on August 5. Taken July 24 to August 3. (Six specimens.)

Lema trilineata Oliv.?—One specimen taken July 22. A larva of this species, determined by Dr. A. G. Boving, was taken as the prey of a nymph of *Perillus bioculatus* (Fab.) (*Hemiptera-Pentatomidae*), on August 22.

Leptinotarsa decemlineata (Say)—Taken August 5. Probably a casual visitant from the adjoining potato fields.

Orthaltica copalina (F.)—One specimen taken July 15.

Paria sp.—Three specimens taken July 5 to 22.

Phyllobrotica decorata Say—One specimen taken June 27.

Phyllobrotica discoides Fab.—One specimen taken June 25.

Phyllotreta sp.—Six specimens taken July 9 to 15, common upon corn plants.

Psylliodes sp.—Two specimens taken July 10 to 17.

Systena blanda (Melsh.)?—Six specimens taken July 9 to 14.

Systena frontalis (F)—One specimen taken July 31.

Cicindellidae

Determinations were made by Mr. E. S. Thomas. Although very abundant in late July, only one species of this family was taken. This was *Cicindela punctulata* Oliv. Five specimens were captured from August 5 to August 31. One was observed to capture and devour a small Carabid beetle, probably *Tachys incurvus* Say, which were abundant in the field, especially after rains and on the moist soil under plant debris. One specimen was observed resting upon a corn leaf.

Coccinellidae

This family was probably the most important group of predators in the field and undoubtedly played an underestimated part not only in the reduction of the numbers of corn borer larvae but other insects as well. Approximately eighty to ninety per cent of the corn plants harbored at least one individual of this group, while as many as six specimens were observed upon one plant. The following specimens were determined by Professor W. C. Stehr.

Adalia bipunctata (L.)—One specimen taken July 9.

Brachyacantha ursina (Fab.)—Two specimens taken July 5 and 24.

Ceratomegilla fuscilabris (Muls.)—This species was very abundant in June and again about the middle of August. On July 14 specimens were observed feeding upon corn pollen which had fallen and collected in the base of the leaves. On July 29 a specimen was taken preying upon *Trigonotilus ruficornis* (Geoffroy) (Hemiptera-Miridae.) On July 21, when the corn plants were manually infested with corn borer eggs, on wax papers, ready to hatch, on fifteen plants examined, one-half hour later, six specimens of this species were observed eating the eggs from the papers. To reach these papers the beetles had to climb or drop to the papers, as these papers were attached to the corn plants upon ordinary dress-makers pins. Numerous specimens were observed parasitized, (estimate about .5%). From two of these parasitized specimens *Dinocampus coccinellae* (Schrank) (Hymenoptera-Braconidae) were reared, one on August 7 and the other in late August. It was interesting

to note, that when forcibly separated from the cocoon of the parasite, these parasitized individuals were capable of considerable activity, although none could be induced to feed.

Chilocerus bivulnerus Muls.—One specimen taken July 5.

Coccinella novem-notata Hbst.—This species was fairly abundant about July 5, taken from June 26 to July 21.

Coccinella trifasciata L.—Two specimens taken July 12 and late August.

Cycloneda munda (Say)—Taken from July 5 to 26, not common.

Hippodamia convergens (Guer.)—Taken June 25 to August 5, most common July 5.

This species was observed feeding upon corn pollen which had collected in the base of the corn leaves. This species was not so commonly parasitized as *Ceratomegilla fuscilabris* (Muls.). *Dinocampus coccinellae* (Schrank), was reared from a specimen collected on a corn leaf in late August.

Hippodamia parenthesis (Say)—Taken July 9 to 30, common.

This species was not so commonly parasitized. *Dinocampus coccinellae* was reared from a specimen collected on a corn leaf on July 19.

Hippodamia parenthesis tridens Kby.—One specimen taken July 18.

Hippodamia tredecim-punctata (L.)—This species was very abundant and predominated in the field in late July. Taken July 11 to late August. None were found parasitized, nor were they observed to feed.

Hyperaspis binotata (Say)—One specimen taken July 25.

Hyperaspis undulata (Say)—One specimen taken July 31.

Cryptophagidae

This family was represented by two species in rather abundant numbers. Determinations were made by Mr. W. S. Fisher.

Anchicera ephippiata Zimm.—Twenty-four specimens taken August 1 to late August.

Anchicera ochracea Zimm.?—Six specimens taken August 1.

Anchicera sp.—One specimen taken August 1.

Cucujidae

This family is represented by only one species which occurred abundantly beneath corn debris on the ground. Specimens were determined by Mr. J. N. Knull.

Telephanus velox Hald.—Thirteen specimens taken August 1 to 5.

Curculionidae

This family occurred in rather abundant numbers upon the corn leaves, although none were observed feeding upon the corn. Determinations were made by Mr. L. L. Buchanan.

Amalus haemorrhous Hbst.—One specimen taken July 18.

Centrinapsis perscitus Hbst.—Two specimens taken July 13, 17.

Baris (near *subsimilis* Csy.)—One specimen taken July 8.

Ceutorhynchus neglectus Blatch.—One specimen taken July 18.

Cryptorhynchus lapathi L.—One specimen taken August 13.

Hypera punctata Fab.—Five specimens taken July 17 to August 7.
Odontocorhynchus sp.—One specimen taken July 8.
Rhinoncus pyrrhopus Boh.—Seven specimens taken July 11 to August 5.
Sitona hispidula Fab.—One specimen taken August 12.
Smicronyx sp.—One specimen taken July 15.

Elateridae

Species of this family were very abundant both on the corn plants and under debris on the ground. Determinations were made by Mr. J. M. Knull and Mr. W. S. Fisher.

Aeolus amabilis (Lec.)—Six specimens taken July 25 to August 1. Common about base of corn plants.
Aeolus elegans Fab.—Eleven specimens taken June 26 to 28, very common under debris and sheaths of leaves at base of plants.
Conoderes auritus Hbst.—Four specimens taken June 24 to 29 in same habitat as the above species.
Conoderes vespertinus (Fab.)—One specimen taken July 28.
Hypnodius obliquatulus Melsh.—Twenty specimens taken June 27 to August 1, very abundant under corn and weed debris.
Hypnodius pectoralis Say—Seventy-two specimens taken June 27 to August 7, same habitat as above species.
Limonius quercinus (Say)—One specimen taken July 5 on corn leaf.

Histeridae

The species of this family were found under debris on the ground. Determinations were made by Mr. J. N. Knull and Mr. H. S. Barber.

Hister abbreviatus F.—Two specimens were collected on August 3 and 5.
Hister americanus Payk.—Three specimens taken August 1 to 7.
Phelister subrotundatus (Say)—Four specimens taken June 27 to August 5.

Hydrophilidae

Determinations were made by Mr. L. L. Buchanan.

Sphaeridium scaraboides L.—One specimen found under corn debris on the ground on July 17.
Tropisternus glaber Hbst.—One specimen taken July 21, lying on back on ground between the corn rows.

Lampyridae

Determinations were made by Mr. H. S. Barber.

Photinus pyralis (L.)—Two specimens taken July 13 and August 13.

Lathriidae

Determinations were made by Mr. W. S. Fisher.

Melanophthalmus cavicollis Mann.—Five specimens taken July 15 to August 1, very abundant under corn debris.

Melasidae

Determination was made by Mr. W. S. Fisher.

Deltometopus amoenicornis (Say)—One specimen taken on corn leaf on August 9.

Meloidae

Determinations were made by Mr. H. S. Barber.

Epicauta pennsylvanica DeG.—Three specimens taken in late August. This species was quite numerous in late August feeding upon the corn pollen.

Macrobasis unicolor (Kby.)—One specimen taken July 18.

Melyridae

Determinations were made by Mr. J. N. Knull.

Collops quadrimaculatus Fab.—Eleven specimens taken June 27 to August 3, very abundant upon the corn plants.

Mordellidae

Determined by Mr. H. S. Barber.

Mordella sp.—One specimen taken July 5.

Mycetophagidae

Determined by Mr. W. S. Fisher.

Typhaea stercorea Linn.—One specimen taken August 5.

Mylabridae

Determinations were made by Mr. H. S. Barber.

Chirida guttata Oliv.—One specimen taken July 9.
Chelymorpha cassidea (F.)—One specimen taken August 5.
Metriona bivittata (F.)—One specimen taken July 8.
Microrhopala vittata (F.)—One specimen taken August 2.

Nitulidae

Determinations were made by Mr. E. A. Chapin.

Glischrochilus quadrisignatus Say—Ten specimens taken July 14 to August 7.

One specimen taken on July 25 was feeding upon a larva of the European Corn Borer, *Pyrausta nubilalis* Hbn. The larva was still partly in a tunnel near a smut lesion when the specimen was collected.

Phalacridae

Species of this family were very abundant upon tassels and leaves of corn plants evidencing smut infection. Determinations were made by Mr. W. S. Fisher.

Phalacrus politus Melsh.—Very abundant, eighteen specimens taken July 9 to August 13.

Stilbus apicalis (Melsh.)—Five specimens taken July 13 to August 3, not quite as abundant as the above species.

Platystomidae

Determinations were made by Mr. L. L. Buchanan.

Brachytarsus sticticus Boh.—Nine specimens taken July 5 to August 7.

Scarabaeidae

Determinations were made by Mr. E. A. Chapin.

Anomala nigropicta Cst.—One specimen taken July 24.

Ataenius cognatus Lec.—Four specimens taken August 2 to 5 under debris on the ground.

Canthon pilularius L.—Pair taken July 13 shaping a ball of horse manure dropped during cultivation of the corn on July 10–11.

Ligyrus gibbosus DeG.—Taken July 19, very abundant just under the surface of the soil under corn and weed debris.

Staphylinidae

Determinations were made by Mr. E. A. Chapin. All of the specimens except as noted, were collected under corn and weed debris upon the ground.

Atheta sp.—Three specimens taken July 15 to 28, on the corn leaves.

Barydoma sp.—One specimen taken July 28.

Coproporus sp.—One specimen taken on corn plant on August 5.

Leptolinus rubripennis Lec.—Taken on August 5, one specimen.

Mycetoporus sp.—Two specimens taken July 15 and August 1.

Philonthus sp.—Three specimens taken July 28 to August 8.

Tenebrionidae

Determined by Mr. E. A. Chapin.

Blapstinus metallicus Fab.—One specimen taken July 9.

Waterfowl Ecology

This little book is the result of an intensive study, over a five-year period, of the blue-winged teal. Most of the study was carried on in two counties of northwestern Iowa, one of the southernmost regions where this duck still nests in abundance. The author made other studies of the blue-winged teal in various mid-western states, and spent a month in its wintering grounds in Mexico.

The chapter headings are an indication of the thoroughness with which the author has discussed the life history and ecology of this bird: Characteristics of the Bird; Breeding Range; Fall Migration; Wintering Grounds; Spring Migration; Courtship and Mating; Nesting; Rearing of Young; Nest Destruction and Juvenile Mortality; Nesting Cover; Rearing Cover; Food Habits; Nesting Populations; Parasites and Disease; Agriculture and Drainage; Breeding, Refuge, and Shooting Areas; Estimating the Yearly Production; Future of the Blue-winged Teal; Summary and Conclusions. The book contains 23 tables and a bibliography of 71 titles, and is illustrated by a color plate, 6 maps, and 31 photographs. The discussion throughout is brief and concise, and is based primarily on the personal observations of the author.

This book is the first complete study of the life history and ecology of a waterfowl ever published. Many practical recommendations in waterfowl management are offered which would be favorable not only to this and other ducks, but to agriculture generally, and to the great sport of duck hunting. This book is one which anyone interested in birds, ecology, wildlife management, or duck hunting would do well to read.—*D. J. Borror.*

The Blue-Winged Teal, Its Ecology and Management, by Logan J. Bennett. xiv+144 pp. Ames, Iowa, Collegiate Press, Inc., 1938. $1.50.

AVIAN HOSTS OF THE GENUS ISOSPORA (COCCIDIIDA)*

DONALD C. BOUGHTON†

With the assistance of

RUTH B. BOUGHTON AND JOSEPH VOLK

As a background for studies on avian coccidiosis it is desirable to know which bird-groups are parasitized by the different genera of Coccidia. To this end the present writer (5) listed the records of the presence of *Eimeria* and *Isospora* by bird orders. It was found, in general, that *Eimeria* was associated with the "lower" orders, and *Isospora*, with the "higher." As a further step toward an understanding of the distribution of avian Coccidia, the present paper assembles the species and subspecies of birds which are known to be capable of harboring *Isospora*.

The data for the host list are derived from three sources: records in the literature; certain unpublished records of Dr. Dora P. Henry; and personal observations. The first two are based upon examinations of hosts killed in their natural habitats. This method has the advantage that it often makes possible histological studies. On the other hand, there are at least two objections to this method. In the first place the hosts must be sacrificed; in the second, replicate observations on questionable cases are impossible. This last point is of particular importance. When the decision between infection and non-infection rests upon the interpretation given to the presence of a few oocysts in the digestive tract, as is the case in many instances, it is of particular advantage to be able to re-examine

*Contribution from the Department of Animal and Plant Pathology, The Rockefeller Institute for Medical Research, Princeton, N. J., and from the Baldwin Bird Research Laboratory (No. 33), Gates Mills, Ohio. The author is indebted to Dr. Dora P. Henry, of the University of Washington, for permission to include the unpublished records on some 75 bird species examined by her in California and Washington; to Mr. Charles Stahnke, for permission to examine a number of captive birds in the Washington Park Zoological Gardens, Milwaukee, Wisconsin; to Mr. S. Prentiss Baldwin and his staff of the Baldwin Bird Research Laboratory, Gates Mills, Ohio, for their hearty co-operation during the summer of 1933, which made possible the examination of 237 individual birds representing 30 species; to Louis Ruhe, Inc., New York City, for permission to examine numerous imported birds; and to Mr. Lee S. Crandall, Curator of Birds, New York Zoological Park, New York City, for the opportunity to examine various captive birds and for his invaluable assistance on nomenclature.

†Zoology Department, University of Georgia, Athens, Ga.

the host under conditions such that a passive ingestion of extraneous oocysts can be ruled out. Of necessity, the records on killed specimens have been taken at face value. The records of the present writer are based on examinations of fecal samples of living birds; some of these were wild birds trapped for examination in their natural habitats and others were captive birds in zoological gardens or pet shops. In the latter group, infections may have been acquired after capture from sources not available in the normal habitats of the hosts. This, however, has no bearing upon the main point of the survey, which is to demonstrate the ability of various bird species to harbor *Isospora*. As a matter of fact many captive birds are probably naturally infected and retain chronic infections over long periods. Such a condition is certainly true for captive house sparrows (6) and is presumably true for certain birds of paradise (3, 4).

The list of hosts is arranged by orders and families, according to Wetmore's classification (25). For each bird species (subspecies when possible) the following details are given: scientific name; common name; a generalized geographical range of the host; a reference to the coccidian species involved, whenever noted as such by an observer; a reference to the authority or authorities for the presence of *Isospora;* and the locality in which the observation was made. In so far as possible, the correct scientific names of hosts, according to the latest nomenclature, are employed. The geographical ranges are included merely as an aid in orientation of host species and to emphasize the world-wide distribution of *Isospora;* the significance of natural habitats in regard to source of infection in the case of captive birds has been discussed above. When a species of *Isospora* has been associated with a given host, this fact is indicated by a Roman numeral which refers to the numbered list of coccidian species given in the text; if no name has been employed the notation "*I.* sp." is used. Authorities for the presence of *Isospora* are indicated by numbers in parentheses, which refer to the numbered list of references at the end of the paper. Unpublished records of Dr. Henry are designated by (14a); when not preceded by a reference to the literature, they constitute new records. The writer's present records are indicated by (*) for captive birds in zoological gardens or pet shops, and by (**) for wild hosts trapped for observation; when not preceded by a reference to a previous observation, these also constitute

new records. All birds reported here for the first time as hosts of *Isospora* are designated by a dagger (†) placed in front of the scientific name.

The following species of avian *Isospora* have been described:

I. *I. lacazii* (Labbé, 1893) from the goldfinch, lark, and other unnamed birds (16). From subsequent host lists (17, 18), the two hosts can be identified as *Carduelis carduelis carduelis* (Linn.) and *Alauda arvensis arvensis* Linn. respectively. In 1896 Labbé (17) listed 30 passerine hosts of this species and in 1899 (18) added several more, most of which had been reported by Sjobring in 1897 (21). In his second and third papers (17, 18) Labbé gave the species as *lacazei*, a spelling which has been employed by most authors since that time. As Henry (14) points out, however, the correct spelling is *lacazii* as originally given by Labbé (16).

Synonyms:

Ia. *I. rivoltae* (Labbé, 1893) from the chaffinch, shrike, titmouse, and other unnamed birds (16). From subsequent host lists, the three hosts can be identified as *Fringilla coelebs coelebs* Linn., *Lanius collurio collurio* (Linn.). *Parus caeruleus caeruleus* Linn. respectively. In his 1896 paper Labbé (17) abandons this species and considers all forms as belonging to *lacazei* (=*lacazii*).

Ib. *I. communis-passerum* Sjöbring, 1897, from a number of passerine birds (21).

II. *I. lyruri* Galli-Valerio, 1931, from the black grouse, *Lyrurus tetrix tetrix* (Linn.) (9). Later Galli-Valerio (10) reports this species from the capercailly, *Tetrao urogallus urogallus* Linn.

III. *I. buteonis* Henry, 1932, from hawks and owls (14). The original host records include: *Accipiter cooperii* (Bonaparte), *Buteo borealis calurus* Cassin, *B. swainsoni* Bonaparte, *Falco sparverius sparverius* Linn., and *Asio flammeus flammeus* (Pontoppidan). A later observation (14a) adds *Bubo virginianus pallescens* Stone.

IV. *I. strigis* Yakimoff and Matschoulsky, 1937, from the short-eared owl, *Asio flammeus leucopsis* (Brem) (29).

V. *I. nucifragae* Galli Valerio, 1933, from the nutcracker, *Nucifraga caryocatactes caryocatactes* (Linn.) (11).

VI. *I. volki* Boughton, 1937, from Lawes' six-plumed bird of paradise, *Parotia lawesi lawesi* Ramsay and 10 other birds of paradise (4).

VII. *I. monedulae* Yakimoff and Matschoulsky, 1936, from the collared jackdaw, *Corvus monedula collaris* Drummond (28).

I. henryi originally described (26) from *Bubo bubo bubo* has been placed in the genus *Caryospora* (27), which is not considered in this paper.

It is not clear from the text of Labbé's 1896 paper (17) whether or not he re-examined the five hosts originally reported (16), but in the present host list he is given credit for so doing.

Records for hosts listed by Labbé in 1899 (18) but not given in his earlier papers are not attributed to him in this paper if they had been published by Sjöbring in 1897 (21). The latter (21) includes two hosts without giving species names (*Fringilla* sp. and *Sylvia* sp.), for which no notation is given in the present host list. Hadley (12) and Johnson (15) incorrectly placed the coccidia found by them in certain passerine birds in the genera *Eimeria* and *Cyclospora* respectively. Sufficient evidence has been presented (22, 1) to show that they were actually dealing with *Isospora*, and their records are included here.

It is not the purpose of this paper to discuss the species of avian *Isospora* in detail, but rather to organize our present knowledge of the distribution of the genus in bird hosts. However, a few remarks on the difficulties of species description in this group may be in order, especially since these difficulties seem to have been too easily set aside by various describers of new coccidian species.

Although the hurried application of a name may be defended, perhaps, on the ground that it provides a convenient handle for subsequent manipulation of the observations—including the final toss into oblivion—nevertheless, limited accounts based on a few oocysts from one or two uncontrolled hosts are not always convincing as descriptions of new species. This appears to be true in the case of avian coccidia for the following reasons:

(a). The actual source of the oocysts may be in doubt, as discussed above.

(b). Oocyst-size, which certainly must be relied upon to some extent, is not without its limitations as a criterion for species differentiation. Some time ago, the writer (2) undertook a detailed study of this character in natural Isosporan infections in English sparrows. The mean size of oocysts varied so much that a single set of 50 or 100 measurements could not be considered representative of the infection as a whole. If we assume that mean size and variability in size remain constant for a given species under various conditions, then the statistically significant differences demonstrated for oocysts from sparrows must be due to the presence of more than one species in the same host. It follows that unless a natural infection is observed for some time, in order to check for significant variations, the possibility that a single host may harbor more than one species must be considered, and until this is ruled out, an isolated series of measurements can have little specific value. Further, it is

not impossible that two species may have statistically identical measurements.

(c). Cross infection experiments seem to be required, especially in the case of passerine infections. Sjöbring (21) suggested that there may be several varieties of coccidia in small birds, each one being pathogenic for its particular host. Laveran (19) and Wasielewski (23) have likewise pointed out the need for cross-innoculation experiments. After examining the oocysts from a number of passerine birds, Henry (14) was led to deliver the following ultimatum: " . . one must draw the conclusion that only one species, *Isospora lacazii*, is represented. At least, with our present methods of differentiation of species, no other conclusion is possible. If experiments could be carried out with these species as easily as with chickens, our knowledge of this form might be extended."

In the present state of our knowledge, it would seem more important to study the distribution of the genus *Isospora* among avian-groups than to establish species. Detailed studies on certain hosts recorded in this paper may eventually aid in the latter. Perhaps it will be possible to study host-specificity by using super-imposed infections. In only one case thus far, the birds of paradise, do the writer's observations seem to warrant the description of a new species. This has been done elsewhere (5).

The following list of avian hosts of *Isospora* includes 176 species and sub-species of birds, representing 130 genera, 40 families, and 9 orders. Over half of these (94 out of 175) are new host records.

Bird Hosts of *Isospora*

ORDER FALCONIFORMES

Family Accipitriidae-Hawks

Accipiter cooperii (Bonaparte). Cooper's hawk. U. S., III (14). California.

Buteo borealis calurus Cassin. Western red-tailed hawk. U. S., III (14). California.

Buteo swainsoni Bonaparte. Swainson's hawk. U. S., III (14). California.

Haliastur indus intermedius (Gurney). Malayan Brahminy kite. P. I., *I.* sp. (13). P. I.

Family Falconidae—Falcons

Falco sparverius sparverius Linn. Eastern sparrow hawk. U. S., III (14). California.

Microchierax erythrogenys (Vigors). Philippine falconet. P. I., *I.* sp. (13). P. I.

ORDER GALLIFORMES

Family Tetraonidae—Grouse

Tetrao urogallus urogallus Linn. Capercailly. Eu., II (10). Switzerland
Lyrurus tetrix tetrix (Linn.). Black grouse. Eu., II (9). Switzerland.

ORDER CHARADRIIFORMES

Family Charadriidae—Plovers, Turnstones, Surf-birds

Vanellus vanellus (Linn.). European lapwing. Eu., *I.* sp. (20). Italy.
Charadrius vociferus vociferus (Linn.). Killdeer. U. S., I (14). California.

ORDER CUCULIFORMES

Family Musophagidae—Plaintain-eaters

†*Turacus leucotis donaldsoni* Sharpe. Donaldson's Turaco. Afr., *I.* sp. (*). New York City.

Family Cuculidae—Cuckoos

Cuculus canorus canorus Linn. European cuckoo. Eu., Ib (21). Sweden.

ORDER STRIGIFORMES

Family Strigidae—Owls

†*Bubo virginianus pallescens* Stone. Western horned owl. U. S., III (14a). Washington.
Asio flammeus flammeus (Pontoppidan). Short-eared owl. U. S., III (14, 14a). California, Washington.
Asio flammeus leucopsis (Brem). Siberian short-eared owl. Asia, IV (29). Taschkent.

ORDER MICROPODIFORMES

Family Micropodidae—Swifts

Apus apus apus (Linn.). European swift. Eu., I (17). France.

ORDER CORACIIFORMES

Family Alcedinidae—Kingfishers

Alcedo atthis ispida Linn. European kingfisher. Eu., I (17). France.
Halcyon coromandus (Latham). Ruddy kingfisher. P. I., *I.* sp. (13). P. I.

Family Coraciidae—Rollers

Coracias garrulus garrulus Linn. European roller. Eu., I (17). France.

Family Upupidae—Hoopoes

Upupa epops epops. European Hoopoe. Eu., I (17). France.

ORDER PICIFORMES

Family Capitonidae—Barbets

†*Cyanops asiatica asiatica* (Latham). Blue-cheeked barbet. India, *I.* sp. (*). New York City.

Family Picidae—Woodpeckers

†*Colaptes auratus luteus* Bangs. Northern flicker. U. S., *I.* sp. (**). Ohio.
Colaptes cafer collaris (Gmelin). Western red-shafted flicker. U. S., I (14). California.
Picus viridis viridis Linn. Green woodpecker. Eu., Ib, I (21, 9). Sweden, Switzerland.
Dryobates minor comminutus (Hart). Br. lesser-spotted woodpecker. Eu., I (18). France.
Jynx torquilla torquilla Linn. Wryneck. Eu. Ib (21). Sweden.

ORDER PASSERIFORMES

Family Tyrannidae—New World Flycatchers

†*Sayornis phoebe* (Latham). Eastern phoebe. U. S., *I.* sp. (**). Ohio.

Family Alaudidae—Larks

Alauda arvensis arvensis Linn. European skylark. Eu., I (16, 17, 19, 23). France (twice), Germany.
Galerida cristata cristata (Linn.). Crested lark. Eu., I (17). France.
†*Otocoris alpestris alpestris* (Linn.). Northern horned lark. U. S., *I.* sp. (**). New Jersey.
†*Otocoris alpestris actia* Oberholser. California horned lark. U. S., *I.* sp. (14a). California.

Family Hirundinidae Swallows

Riparia riparia riparia (Linn.). Bank swallow. Eu., I (17). France.
Hirundo urbica urbica Linn. European martin. Eu., I (17) France.
Chelidon rustica rustica (Linn.). European swallow. Eu., I (17). France.

Family Campephagidae—Cuckoo-shrikes

Lalage niger (Forster). Pied lalage. P. I., *I.* sp. (13). P. I.

Family Oriolidae—Old World Orioles

Oriolus oriolus oriolus (Linn.). European golden oriole. Eu., I (17). France.

Family Corvidae—Jays, Crows, Magpies

†*Amphelocoma californica californica* (Vigors). California jay. U. S., *I.* sp. (14a). California.
†*Amphelocoma californica immanis* Grinnell. Long-tailed jay. U. S., *I.* sp. (14a). California
†*Amphelocoma californica oocleptica* Swarth. Nicasio jay. U. S., *I.* sp. (14a). California.
Corvus brachyrynchos brachyrynchos Brehm. Eastern crow. U. S., *I.* sp. (1, **). Minnesota, New Jersey.

†*Corvus brachyrynchos hesperis* Ridgway. Western crow. U. S., *I.* sp. (14a). California.
†*Corvus caurinus* Baird. Northwestern crow. U. S., *I.* sp. (14a). Washington.
Corvus cornix cornix Linn. Hooded crow. Eu., Ib (21). Sweden.
Corvus corone corone Linn. European carrion crow. Eu., I (17, 23). France, Germany.
Corvus monedula collaris Drummond. Collared jackdaw. Asia, VII (28). Taschkent.
Nucifraga caryocatactes caryocatactes (Linn.). Nutcracker. Eu., V (11). Switzerland.
†*Dendrocitta rufa rufa* (Latham). Wandering tree magpie. India, *I.* sp. (*). New York City.
†*Pica pica pica* Linn. European magpie. Eu., *I.* sp. (*). New York City.

Family Paradiseidae—Birds of Paradise

Paradisaea apoda apoda Linn. Greater bird of paradise. New Guinea, VI (4). New York City.
Paradisaea apoda salvadori Mayr and Rand. Count Salvadori's bird of paradise. New Guinea, VI (4). New York City.
Paradisaea guilelmi Cabanis. Emperor of Germany's bird of paradise. New Guinea, VI (4). New York City.
Paradisaea minor minor Shaw. Lesser bird of paradise. New Guinea, VI, (4). New York City.
Paradisornis rudolphi rudolphi Finsch. Prince Rudolph's bird of paradise. New Guinea, VI (4). New York City.
Parotia lawesi lawesi Ramsay. Lawes' six-plumed bird of paradise. New Guinea, VI (3, 4). Milwaukee, New York City.
Epimachus meyeri meyeri Finsch. Long-tailed bird of paradise. New Guinea, VI (4). New York City.
Seleucides melanoleucus melanoleucus (Daudin). Twelve-wired bird of paradise. New Guinea, VI (4). New York City.
Lophorina superba minor Ramsay. Lesser superb bird of paradise. New Guinea, VI (4). New York City.
Uranornis rubra (Daudin). Red bird of paradise. New Guinea, VI (4). New York City.
Manucodia chalybatus orientalis Salvadori. Blue manucode. Papuan Islands, VI (4). New York City.

Family Paridae—Titmice

Parus caeruleus caeruleus Linn. Continental blue titmouse. Eu., Ia, I (16, 17). France.
Parus major major Linn. Great titmouse. Eu., I (23). Germany.
†*Baeolophus inornatus inornatus* (Gambel). Plain titmouse. U. S., *I.* sp. (14a). California.

Family Sittidae—Nuthatches

†*Sitta carolinensis carolinensis* Latham. Northern white-breasted nuthatch. U. S., *I.* sp. (**). Ohio.
†*Sitta carolinensis aculeata* Cassin. Slender-billed nuthatch. U. S., *I.* sp. (14a). California.

Family Timaliidae—Babbling Thrushes

†*Leioptila capistrata capistrata* (Vigors). Black-headed sibia. India, *I*. sp. (*). New York City.
†*Pyctorhis sinensis sinensis* (Gmelin). Golden-eyed babler. India, *I*. sp. (*). New York City.
†*Mesia argentauris argentauris* Hodgson. Silver-eared hill-tit. India, *I*. sp. (*) New York City.
†*Liothrix lutea lutea* (Scopoli). Red-billed hill-tit. China, *I*. sp. (*). New York City.
†*Garrulax leucolophus leucolophus* (Hardwicke). White headed jay thrush. India, *I*. sp. (*). New York City.
†*Garrulax albogularis albogularis* (Gould). White-throated jay thrush. India, *I*. sp. (*). New York City.
†*Trochalopterum lineatum* (Vigors). Streaked jay thrush. India, *I*. sp. (*). New York City.

Family Pycnonotidae—Bulbuls

†*Otocompsa flaviventris flaviventris* (Tick.). Black-crested yellow bulbul. India, *I*. sp. (*). New York City.
†*Chloropsis aurifrons aurifrons* (Temm.). Golden-fronted green bulbul. India, *I*. sp. (*). New York City.
†*Molpastes haemorrhous bengalensis* Blyth. Bengal black bulbul. India, *I*. sp. (*). New York City.

Family Troglodytidae—Wrens

†*Troglodytes aëdon aëdon* Vieillot. Eastern house wren. U. S., *I*. sp. (**). Ohio.

Family Mimidae—Thrashers, Mockingbirds

†*Mimus polyglottos leucopterus* (Vigors). Western mockingbird. U. S., *I*. sp. (14a). California.
†*Mimus gilvus melanopterus* Lawrence. Black-winged mockingbird. S. A., *I*. sp. (*). New York City.
†*Dumetella carolinensis* (Linn.). Catbird. U. S., *I*. sp. (**). Ohio.
†*Toxostoma rufum* (Linn.). Brown thrasher. U. S., *I*. sp. (**). Ohio.
†*Melanotus caerulescens* (Swainson). Blue mockingthrush. C. A., *I*. sp. (*). Milwaukee.

Family Turdidae—Thrushes

Turdus migratorius migratorius Linn. Eastern robin. U. S., *I*. sp. (12, **). Rhode Island, Wisconsin.
Turdus migratorius propinquus Ridgway. Western robin U. S., I (14). California.
Turdus merula merula Linn. European blackbird. Eu., I (17, 9). France, Switzerland.
Turdus iliacus iliacus Linn. Redwing. Eu., I (8). Switzerland.
†*Turdus torquatus alpestrias* (Brehm). Alpine ring ouzel. Eu., *I*. sp. (*). Milwaukee.
Hylocichla guttata faxoni Bangs and Penard. Eastern hermit thrush. U. S., *I*. sp. (12). Rhode Island.

†*Ixoreus naevius meruloides* (Swainson). Northern varied thrush. U. S., *I*. sp. (14a). Washington.

†*Arceuthornis musicus musicus* (Linn.). Red-winged thrush. Eu., *I*. sp. (*). New York City.

†*Arceuthornis philomelos philomelos* (Brehm). Continental song thrush. Eu., *I*. sp. (*). New York City.

Kittacincla malabarica malabarica (Scopoli). Indian shama thrush. India, *I*. sp. (*). New York City.

†*Sialia sialis sialis* (Linn.). Eastern bluebird. U. S., *I*. sp. (**). Ohio.

†*Sialia mexicana occidentalis* Townsend. Western bluebird. U. S., *I*. sp. (14a). California.

Oenanthe oenanthe oenanthe (Linn.). European wheatear. Eu., *I*. sp. (17). France.

Erithacus rubecula rubecula (Linn.). Continental robin redbreast. Eu., I (20, 17). Italy, France.

Erithacus phoenicurus (Linn.)? Nightingale. Eu., Ib (21). Sweden.

Family Sylviidae—Old World Warblers

Sylvia atricapilla atricapilla (Linn.). Blackcap warbler. Eu., I (20, 17). Italy, France.

Sylvia borin (Boddaert). Garden warbler. Eu., I (17, 23). France, Germany.

Family Regulidae—Kinglets

†*Regulus satrapa satrapa* Lichtenstein. Eastern golden-crowned kinglet. U. S., *I*. sp. (**). New Jersey.

†*Polioptila caerulea amoenissima* Grinnell. Western gnatcatcher. U. S., *I*. sp. (14a). California.

Family Muscicapidae—Old World Flycatchers

Fridecula hypoleuca hypoleuca (Pallas). Pied flycatcher. Eu., Ib (21). Sweden.

Family Motacillidae—Wagtails, Pipits

Motacilla alba alba Linn. White wagtail. Eu., I, Ib (17, 21). France, Sweden.

Motacilla flava flava Linn. Blue-headed wagtail. Eu., I (17). France.

Anthus pratensis pratensis Linn. European meadow pipit. Eu., I (17). France.

†*Anthus spinoletta rubescens* (Tunstall). American pipit. U. S., *I*. sp. (14a). California.

Family Laniidae—Shrikes

Lanius collurio collurio (Linn.). Red-backed shrike. Eu., Ia, Ib (16, 21). Sweden.

Otomela lucionensis (Linn.). Gray-headed shrike. P. I., *I*. sp. (13). P. I.

Family Sturnidae (including Graculidae)—Starlings, Mynahs

Sturnus vulgaris vulgaris Linn. European starling. Eu., U. S., I, *I*. sp. (17, **). France, Ohio.

Sturnia sinensis (Gmelin). Gray-backed starling. P. I., *I*. sp. (13). P. I.

†*Sturnia malabarica malabarica* (Gmelin). Malabar mynah. India. *I*. sp. (*). New York City.
†*Creatophora carunculata* (Gmelin). Wattled starling. Afr., *I*. sp. (*). New York City.
†*Temenuchus pagodarum* (Gmelin). Black-headed mynah. India, *I*. sp. (*). Milwaukee.
Aethiopsar cristatellus cristatellus (Linn.). Crested mynah. P. I., *I*. sp. (13). P. I.
†*Gracula religiosa religiosa* Linn. Javan hill mynah. Java, *I*. sp. (*). Milwaukee.
†*Gracula indica* (Cuvier). Lesser hill mynah. India, *I*. sp. (*). New York City.
†*Galeospar salvadorii* Sharpe. Crested glossy starling. Afr., *I*. sp. (*). New York City.
†*Spreo superbus* (Rupp.). Superb glossy starling. Afr., *I*. sp. (*). Milwaukee.
†*Lamprocorax panayensis halyctipus* Oberholser. Malay glossy starling. Afr., *I*. sp. (*). Milwaukee.

FAMILY VIREONIDAE—VIREOS

†*Vireo olivaceus* (Linn.). Red-eyed vireo. U. S., *I*. sp. (**). Ohio.

FAMILY COEREBIDAE—HONEY-CREEPERS

†*Cyanerpes cyaneus* (Linn.). Honey-creeper. S. A., *I*. sp. (*). Milwaukee.

FAMILY COMPSOTHLYPIDAE—WOOD WARBLERS

†*Geothlypis trichas brachidactyla* (Swainson). Northern yellow-throat. U. S., *I*. sp. (**). Ohio.

FAMILY PLOCEIDAE—WEAVER-FINCHES

†*Euodice cantans cantans* (Gmelin). African silverbill. Afr., *I*. sp. (*). New York City.
Euodice malabarica } Hybrid, Bengalee mannikin. Afr., *I*. sp. (*).
†*Uroloncha tsriata tsriata* } New York City.
†*Ploceus velatus arundinarius* (Burch.). Cape or masked weaver. Afr., *I*. sp. (*). Milwaukee.
Padda oryzivora (Linn.). White Java sparrow. Java, *I*. sp. (13, *). P. I., New York City.
†*Taeniopygia castanotis castonotis* (Gould). Zebra finch. Australia, *I*. sp. (*). New York City.
†*Amandava amandava* (Linn.). Strawberry finch. India, *I*. sp. (*). New York City.
Amadina erythrocephala (Linn.). Red-headed finch. Afr., *I*. sp. (*). New York City.
†*Estrilda astrild astrild* (Linn.). St. Helena waxbill. Afr., *I*. sp. (*). New York City.
†*Estrilda melpoda melpoda* (Vieillot). Orange-cheeked waxbill. Afr., *I*. sp. (*). New York City.
Passer domesticus domesticus (Linn.). English sparrow. Eu., U. S. I (Many authors). *Vide* (6).

Passer montanus montanus (Linn.). Mountain or European tree sparrow. Eu., *I.* sp., I (13, 9). P. I., Switzerland.

Passer italiae (Vieillot). Italian sparrow. Eu., *I.* sp. (20). Italy.

Family Icteridae—Blackbirds, Troupials

†*Icterus icterus icterus* (Linn.). Common troupial. S. A., *I.* sp. (*). New York City, Miami.

†*Icterus bullockii* (Swainson). Bullock's oriole. U. S., *I.* sp. (14a). California.

†*Gymnomystax mexicanus* (Linn.). Giant oriole. S. A., *I.* sp. (*). New York City.

†*Sturnella neglecta* Audubon. Western meadowlark. U. S., *I.* sp. (14a). California.

Euphagus cyanocephalus (Wagler). Brewer's blackbird. U. S., *I.* sp. (15, 14a). Washington (twice).

†*Xanthocephalus xanthocephalus* (Bonaparte). Yellow-headed blackbird. U. S., *I.* sp. (14a). California.

†*Leistes militarias superciliaris* (Bonaparte). Argentine red-breasted blackbird. S. A., *I.* sp. (*). New York City.

†*Agelaius phoeniceus californicus* Nelson. Bicolored red-winged blackbird. U. S., *I.* sp. (14a). California.

†*Quiscalus quiscula aeneus* Ridgway. Bronzed grackle. U. S., *I.* sp. (**). Ohio.

†*Molothrus ater ater* (Boddaert). Eastern cowbird. U. S., *I.* sp. (**). Ohio.

Family Thraupidae—Tanagers

†*Thraupis palmarum palmarum* (Wied). Southern palm tanager. S. A., *I.* sp. (*). New York City.

†*Rhamphocelus brasileus* (Linn.). Brazilian silver-beaked tanager. S. A., *I.* sp. (*). Milwaukee.

†*Rhamphocelus carbo carbo* (Pallas). Southern silver-beaked tanager. S. A., *I.* sp. (*). New York City.

†*Cissopis leveriana* (Gmelin). Magpie-tanager. S. A., *I.* sp. (*). New York City.

Family Fringillidae—Grosbeaks, Finches, Buntings

†*Richmondena cardinalis carindalis* (Linn.). Eastern cardinal. U. S., *I.* sp. (**). Ohio.

†*Hydymeles ludovicianus* (Linn.). Rose-breasted grosbeak. U. S., *I.* sp. (**). Ohio.

†*Passerina ciris* (Linn.). Painted bunting. C. A., *I.* sp. (*). Milwaukee.

Emberiza citrinella citrinella Linn. Yellow hammer. Eu., I, Ib (17, 21, 23, *). France, Sweden, Germany, New York City.

†*Sycalis flaveola flaveola* (Linn.). Common saffron finch. S. A., *I.* sp. (*). New York City.

†*Spinus tristis tristis* (Linn.). Eastern goldfinch. U. S., *I.* sp. (**). Ohio.

Carduelis carduelis carduelis (Linn.). European goldfinch. Eu., Ia, I (16, 17, 9). France, Switzerland.

Acanthis cannabina cannabina (Linn.). Linnet. Eu., I (17, 23). France, Germany.

Chloris chloris chloris (Linn.). European green finch. Eu., I (17). France.

Fringilla coelebs coelebs Linn. Chaffinch Eu., Ia, I (16, 17, 23). France, Germany.

Fringilla montifringilla Linn. Brambling. Eu., I (17). France.

Coccothraustes coccothraustes coccothraustes (Linn.). European hawfinch. Eu., *I.* sp., I (7, 8, 10). Italy, Switzerland (twice).

Pyrrhula pyrrhula pileata Macgillivray. British bullfinch. Eu., I (17). France.

†*Carpodacus mexicanus frontalis* (Say). Common house finch. U. S., *I.* sp. (14a). California.

†*Carpodacus purpureus purpureus* (Gmelin). Eastern purple finch. U. S., *I.* sp. (**). Ohio.

†*Pipilo erythrophthalmus erythrophthalmus* (Linn.). Red-eyed towhee. U. S., *I.* sp. (**). Ohio.

†*Pipilo fuscus albigula* Baird. San Lucas towhee. U. S., *I.* sp. (14a). California.

†*Pipilo maculatus falcifer* McGregor. San Francisco towhee. U. S., *I.* sp. (14a). California.

†*Passerculus sandwichensis savanna* (Wilson). Eastern Savannah sparrow. U. S., *I.* sp. (**). Ohio.

Melospiza melodia melodia (Wilson). Eastern song sparrow. U. S., *I.* sp. (**). Ohio, Minnesota.

†*Chondestes grammacus strigatus* Swainson. Western lark sparrow. U. S., *I.* sp. (14a). California.

Junco hyemalis hyemalis (Linn.). Slate-colored junco. U. S., *I.* sp (12). Rhode Island.

†*Junco oreganus oreganus* (Townsend). Oregon junco. U. S., *I.* sp. (14a). California.

Zonotrichia albicollis (Gmelin). White-throated sparrow. U. S., *I.* sp. (12, **). Rhode Island, New Jersey.

†*Zonotrichia leucophrys leucophrys* (Forster). White-crowned sparrow. U. S., *I.* sp. (14a). California.

†*Zonotrichia leucophrys gambeli* (Nuttall). Gambel's sparrow. U. S., *I.* sp. (14a). California.

†*Zonotrichia coronata* (Pallas). Golden-crowned sparrow. U. S., *I.* sp. (14a). California.

†*Spizella passerina passernia* (Bechstein). Eastern chipping sparrow. *I.* sp. (**). Ohio.

†*Spizella passerina arizonae* Coues. Western chipping sparrow. U. S., *I.* sp. (14a). California.

Spizella pusilla pusilla (Wilson). Eastern field sparrow. U. S., *I.* sp. (12, **). Rhode Island, Ohio.

---

* Author's record on captive bird.
** Author's record on wild bird.
† New host for *Isospora*.

I. *I. lacazii* (Labbé, 1893).
Ia. *I. rivoltae* (Labbé, 1893).
Ib. *I. communis-passerum* Sjöbring, 1897.
II. *I. lyruri* Galli-Valerio, 1931.
III. *I. buteonis* Henry, 1932.
IV. *I. strigis* Yakimoff and Mat., 1937.
V. *I. nucifragae* Galli-Valerio, 1933.
VI. *I. volki* Boughton, 1937.
VII. *I. monedulae* Yakimoff and Mat., 1936.

SUMMARY

The list of avian hosts of the genus *Isospora* recorded in this paper is comprised of 176 species and sub-species of birds. These represent 130 genera, 40 families, and 9 orders. Of the entire list, 94 hosts are reported for the first time: 27 through the courtesy of Dr. Dora P. Henry and 67 representing the author's own observations. Of the latter, 21 were wild hosts examined in their natural habitats and 46 were captive birds.

REFERENCES CITED

(1) **Boughton, Donald C.** 1929. A Note on Coccidiosis in Sparrows and Poultry. Poult. Sci. 8: 184–188.
(2) 1930. The Value of Measurements in the Study of a protozoan parasite *Isospora lacazei* (Labbé). Am. Journ. Hyg. 11: 212–226.
(3) 1933. A Coccidial Infection in a Bird of Paradise. Zeitschrift f. Parasitenk. 6: 147–149.
(4) 1937. *Isospora volki* n. sp., a New Avian Coccidian. Journ. Parasitol. 23: 97–98.
(5) 1937a. Notes on Avian Coccidiosis. The Auk, 54: 500–509.
(6) 1937b. Studies on Oocyst-Production in Avian Coccidiosis. II. Chronic Isosporan Infections in the Sparrow. Am. Journ. Hyg., 25: 203–211.
(7) **Condorelli, M.** and **Fiore, C. de.** 1892. Un caso di psorospermosi intestinale nel *Coccothraustes vulgaris*. Boll. Soc. Rom. Studi Zoolog. I, 68.
(8) **Galli-Valerio, B.** 1929. Notes de Parasitologie. Centralbl. Bakt. etc., I. Orig. 112: 54–60.
(9) 1931. Notes de Parasitologie. *Ibid.*, 120: 98–106.
(10) 1932. Notes de Parasitologie et de Technique Parasitologique. *Ibid.*, 125: 129–142.
(11) 1933. Notes Parasitologiques et de Technique Parasitologique. *Ibid.*, 129: 422–433.
(12) **Hadley, P. B.** 1910. Studies in Avian Coccidiosis. III. Coccidiosis in the English Sparrow and Other Wild Birds. *Ibid.*, 56: 522–523.
(13) **Hegner, Robert,** and **Chu, H. J.** 1930. A Survey of Protozoa Parasitic in Plants and Animals of the Philippine Islands. Philip. Journ. Sci. 43: 451–480.
(14) **Henry, Dora P.** 1932. *Isospora buteonis* sp. nov. from the Hawk and Owl, and notes on *Isospora lacazii* (Labbé) in Birds. Univ. Calif. Publ. Zool. 37: 291–300.
(14a) Personal Communication.
(15) **Johnson, W. T.** 1923. Avian Coccidiosis. Poult. Sci. 2: 146–163.
(16) **Labbé, A.** 1893. Sur les Coccidies des Oiseaux. C. R. Acad. Sci. 116: 1300–1303.
(17) 1896. Recherches Zoologiques, Cytologiques et Biologiques sur les Coccidies. Arch. Zool. Expér., Series 3, 4: 517–654.
(18) 1899. "Sporozoa" in: Das Tierreich, 5: pp. xx, 1–180. Berlin.
(19) **Laveran, A.** 1898. Sur les Modes de Reproduction d'*Isospora lacazei.* C. R. Soc. Biol. 5: 1139–1142.
(20) **Rivolta, S.,** and **Delprato, P.** 1881. L'ornitoiatria o la Medicina degli Ucelli Domestici e Semidomestici. Pisa.
(21) **Sjöbring, N.** 1897. Beitrage zur Kenntnis einiger Protozoen. Centralbl. f. Bakt., etc., 22: 675–680.
(22) **Smith, T.,** and **Smillie, E. W.** 1917. Note on Coccidia in Sparrows and their Assumed Relation to Blackhead in Turkeys. Journ. Exp. Med. 25: 415–420.
(23) **Wasielewski, T. von.** 1904. Studien und Mikorphotogramme zur Kenntnis der Pathogenen Protozoen. 1 Heft. III. Über den Erreger einer Coccidienseuche bei Vöglen (*Diplospora lacazei*). 69–88. Leipzig.

(24) **Wenyon, C. M.** 1926. Protozoology. A Manual for Medical Men, Veterinarians and Zoologists. 2 vols., pp. xvi, 1563. London.
(25) **Wetmore, A.** 1934. A Systematic Classification for the Birds of the World. Revised and Amended. Smithsonian Misc. Coll. 89 (No. 13): 1–11.
(26) **Yakimoff, W.,** and **Matikaschwili,** I. 1932. La Coccidie du hibou. Bul. Soc. Path. Exot. 25: 1045.
(27) **Yakimoff, W.,** and **Matschoulsky, S. N.** 1936. On the Coccidia of Birds of Prey. Journ. R. Soc. Microscop. Soc. 55: 372–375.
(28) ——— 1936a. Eine kokzidie der Dohle. Munchener Tierarztlichen Wochenschrift. 87 (No. 51): 603.
(29) ——— 1937. *Isospora strigis* n. sp., Eine neue Eulencoccidie. Archiv. f. Protistenk. 88: 286–288.

Forest Pathology

The more important diseases of forest trees, from the seedlings in the nursery or the forest to the mature veterans ready to harvest, are discussed in this text. Foresters, forestry students, plant pathologists, and shade tree specialists should find it valuable in diagnosing tree diseases. The plan of the book is based on the tree organs affected by disease, such as root, stem, and foliage; since most foresters are not mycologists, this appears to be more satisfactory than the customary organization based on the taxonomic relationships of the causal agents.

The causes of diseases, their expressions in symptoms and signs, and their various classifications are outlined in an early chapter. The trunk or stem of a forest tree is the salable portion, and its diseases are considered in most detail. A discussion of the decay of standing timber, the deterioration of forest products and of sap stains, all of which are of great economic importance to the lumberman and the public, occupies nearly one hundred pages. Foresters generally regard heart rots of standing timber as diseases, even though that portion of the suscept is non-living.

The principles of forest-disease control are outlined, but only those few measures which fit into routine silvicultural practice are considered. Protection by fungicides and eradication of diseased trees are seldom practiced, because of the relatively low value per unit area of the forest crop. In the nurseries, where unit values are high, direct control measures, such as protection by spraying or dusting, are economically possible.

On the whole, this text appears to be one of the best in its field. Half-tone illustrations are plentiful, and a selected list of references is appended to each chapter.—*A. L. Pierstorff.*

Forest Pathology, by John Shaw Boyce. x+600 pp. New York, the McGraw-Hill Book Company, 1938. $5.00.

Scientific Illustration

A recent publication entitled "Scientific Illustration" appears to be a very useful book on this subject. It presents methods and equipment essential for the production of satisfactory drawings and illustrations for scientific publications.

Fifty-eight topics are discussed and illustrated. Some of these deal with kinds of illustrations; requirements, methods and equipment useful in the preparation of drawings, especially natural history drawings; light and shade effects; photographs, their composition and preparation; proof reading illustrations and the process of reproducing illustrations. A number of topics discuss and illustrate thoroughly maps and their preparation. This should be of decided interest and value to geographers and geologists.

The illustrations, found on the 22 plates and among the 23 figures, are especially good and illustrate high grade scientific work. In general the book should be very useful to advanced students and investigators looking for suggestions on how to prepare illustrations for their scientific publications.—*Alvah Peterson.*

Scientific Illustration, by J. L. Ridgway. 173 pp., 22 plates, 23 figures. Stanford University Press, Stanford University, California. 1937. $4.00.

THE ALIMENTARY CANAL OF THE APHID PROCIPHILUS TESSELATA FITCH.

JOHN Z. PELTON,
Ohio State University

INTRODUCTION

The Woolly Alder Aphis (*Prociphilus tesselata* Fitch), is a sucking insect feeding on alder. It is commonly found throughout the State of Ohio.

The study that follows was made upon the suggestion of Dr. C. H. Kennedy, and was begun in a course on "The Morphology and Development of Insects."

The material used was collected on the bank of Minerva Lake, at Columbus, Ohio, October 9, 1936. The aphids were brought into the laboratory and kept alive on a branch of alder for several weeks. Live material was kept alive in the laboratory and used from time to time over a period of five weeks. Specimens were opened and fixed in Kahle's solution for 24 hours, and preserved in 70% alcohol.

The author wishes to express his appreciation for the helpful suggestions and criticisms of Dr. C. H. Kennedy, under whose direction this study was made.

GROSS ANATOMY OF THE DIGESTIVE TRACT

General Anatomy

The alimentary canal consists of a long tube with a few convolutions, which is characteristic of sucking insects. The canal is approximately two and one-half times the length of the insect's body. Morphologically the canal is divisible into three primary regions according to their embryonic origin. The fore-intestine (stomodaeum) arises as an anterior ectodermal invagination, the hind-intestine (proctodaeum) arises as a similar posterior invagination; while the epithelium on the mid-intestine arises from embryonic endoderm, the muscular layers in the same region are derived from mesodermal tissue.

Fore-Intestine

The fore-intestine is a comparatively short, slender tube which consists of the following regions: pharynx, oesophagus, and oesophageal valve.

The pharynx is the slight enlargement of the fore-intestine just posterior to the mouth which connects the mouth with the oesophagus.

The oesophagus is a short, narrow tube connecting the pharynx with the mid-intestine (Pl. I, fig. 1). It is located running through the prothorax and mesothorax. At the junction of the oesophagus

and the mid-intestine is located the oesophageal valve which projects into the lumen of the mid-intestine.

The oesophageal valve is rather well developed and marks the division between the fore-intestine and mid-intestine. It is found near the junction of the mesothoracic and metathoracic segments.

The salivary glands are represented by two small oval bodies located dorsally, left and right respectively to the oesophagus between the prothoracic and mesothoracic segments (Pl. I, fig. 1). They connect with the oesophagus by a simple forked tube.

Mid-Intestine

The mid-intestine, mesenteron, forms about two-thirds of the alimentary tract (Pl. I, fig. 1). It is marked at its anterior end by the oesophageal valve, located near the anterior part of the metothorasic segment, and at the posterior end by the pyloric valve located in the first abdominal segment. The size of the mid-intestine or stomach varied with the different specimens dissected. The anterior part of the mid-intestine is shaped like a large bulb with a small constriction at the posterior part of the bulb. The stomach runs posteriorly to the ninth abdominal segment where a turn occurs, a short lateral wave with a complete reverse turn cephalad to the middle of the metathoracic segment where it folds a figure U dorsally on the bulb part of the stomach. After forming the U, the stomach bends down around the bulb part and turns back posteriorly on the ventral side of the bulb, where the pyloric valve occurs in the anterior part of the first abdominal segment, or as far forward as the metathorax. No malpighian tubules were found. Weber, in his "Lehrbuch der Entomologie," states that aphids lack malpighian tubules.

Hind-Intestine

The hind-intestine lacks malpighian tubules, and consists of a pyloric valve and a sac-like portion, having the structure of a rectum, which gradually enlarges toward the anus. G. F. Knowlton found the hind-intestine of *Longistigma caryae* (Harris) connects with the anus by a thick-walled rectum which has only a small opening through the center.

The pyloric valve is recognized by the constriction at the posterior end of the mid-intestine (Pl. I, fig. 5). It is located in the posterior part of the metathoracic segment, or in the first abdominal segment.

HISTOLOGY OF THE ALIMENTARY CANAL

Fore-Intestine

The fore-intestine is histologically composed of the same parts throughout its length, but there is some variation in development of the parts.

The intima, or cuticula of chitin, is homologous with the cuticula of the body-wall. It is thin and very delicate for most of the distance through the fore-intestine, which it lines throughout.

The epithelium is thin, the cells are small rectangular, the nuclei of medium size, oval to round and quite centrally located. Nucleus

and cytoplasm are granular. The basement membrane cannot be distinguished.

Outside of the epithelial layer are found delicate scattered strands of longitudinal muscles at irregular intervals.

Surrounding the longitudinal muscles is a fairly continuous layer of circular muscles.

The oesophageal valve (Pl. I, fig. 4), marks the junction of the fore-intestine with the mid-intestine. The valve consists of a fold of epithelium, delicate cuticula from the oesophagus, which extends well into the fore-end of the mid-intestine. The folds of epithelium then turn back and join the large stomach digestive epithelium cells at the point where the oesophagus enters the mid-intestine. Histologically the parts coincide with the same structures in the oesophagus.

Mid-Intestine

The mid-intestine or stomach is the part of the alimentary canal posterior to the oesophageal valve and anterior to the pyloric valve.

The mid-intestine is quite long, being about two-thirds the length of the entire tract and easily distinguished from the other parts of the tract.

No evidence of the peritrophic membrane could be found. G. F. Knowlton, working on *Longistigma caryae*, found: "The peritrophic membranes or some membranous tissue is found covering the inner surface of the digestive epithelium cells in the closed and partly closed portion of the stomach, but is not present apparently, in the open stomach except where no signs of recent digestion are in evidence."

The ring of columnar shaped cells in the stomach around the oesophageal valve (Pl. I, fig. 4) may be the remains of the cells that secrete the peritrophic membrane in such insects as have a peritrophic membrane. E. P. Breakey, working on *Anasa tristis*, found a similar ring of cells and suggested that they may represent a ring of "peretrophic cells." So it appears for the first time that a circle of "peritrophic cells" has been found in Aphids.

The digestive epithelium is composed of large irregular cells with large oval nuclei, and the cytoplasm as well as the nucleus granular.

The basement membrane is a rather thick, structureless membrane and quite distinct.

The muscular layer is composed of circular fibers next the basement membrane, outside of which are thin strands of longitudinal fibers. The order of these layers is just the reverse of that of the muscular layers on the oesophagus, where the longitudinal fibers are inside the layer of circular fibers. The two layers are reversed at the oesophageal valve where the bundles of fibers interlace.

Hind-Intestine

The hind-intestine, more than half as long as the aphid, is marked anteriorly by the pyloric valve and posteriorly by the anus.

The pyloric valve, (Pl. II, fig. 9), consists of a slight constriction and differentiation of cells. The large irregular cells of the mid-intestine end abruptly and the irregular columnar cells of the hind-intestine arise. For the first time, so it appears, a pyloric valve has been found and

identified in the Aphids. This pyloric valve lacks a muscular band and cannot close. As a result, the pyloric valve is not a true valve as such.

The intima is delicate but clearly distinguishable.

The epithelium consists of irregular columnar shaped cells with oval shaped nuclei and with the cell walls seldom distinguishable.

The hind-intestine gradually enlarges into a rectum (Pl. II, fig. 10), the cells increasing slightly in size.

The basement membrane of the epithelium is structureless and rather indistinct.

The inner circular muscles form a delicate layer throughout the length of the hind-intestine. The longitudinal muscles are delicate, scattered strands. No outer circular muscles are in evidence.

BIBLIOGRAPHY

Baker, A. C. 1915. The Woolly Apple Aphis. U. S. Dept. Agr., Dept. Report 101: 1–55.

Breakey, E. P. 1936. Histological Studies of the Digestive System of the Squash Bug, *Anasa tristis* De G. Ann. Ent. Soc. America, 29: 561–577, 4 pls.

Comstock, J. H. 1924. An Introduction to Entomology; 107–113, 128 figs.

Knowlton, G. F. 1925. The Digestive Tract of *Longistigma caryae* (Harris). Ohio Journal of Science, 25: 244–252, 2 pls.

Miller, F. W. 1932. The Digestive Epithelium of the Aphid *Macrosiphium sanborini*. Penna. Academy of Science, 6.

Snodgrass, R. E. 1935. Principles of Insect Morphology. McGraw-Hill Publishing Company; 347–387, 2 figs.

Weber, H. 1933. Lehrbuch der Entomologie. Gustav Fisher. Jena; 398; 372 figs.
1930. Biologie der Hemipteren. Julius Springer, Berlin; 239; 181 figs.

EXPLANATION OF PLATES

Plate I

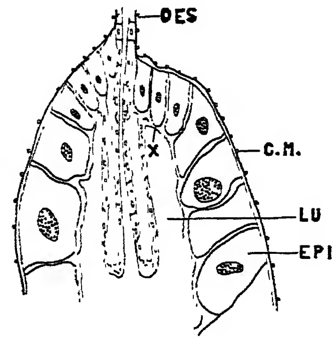
Fig. 1. Gross dissection; dorsal view of alimentary canal and salivary glands to show relative size and relation of parts.
Fig. 2. Cross-section through a salivary gland.
Fig. 3. Cross-section through the oesophagus.
Fig. 4. Longitudinal section through a portion of the oesophagus, the oesophageal valve and part of the stomach.
Fig. 5. Gross dissection; ventral view of portion of alimentary canal showing relative size and location of pyloric valve.
Fig. 6. Cross-section through constriction at posterior end of bulb part of mid-intestine.

Plate II

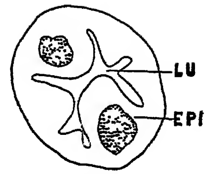
Fig. 7. Cross-section through stomach at oesophageal valve.
Fig. 8. Cross-section through mid-intestine below constriction.
Fig. 9. Longitudinal section through pyloric valve.
Fig. 10. Cross-section through hind-intestine, rectum.

KEY TO ABBREVIATIONS

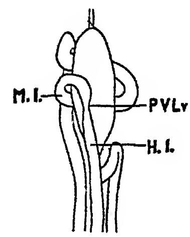
C. M.—Circular Muscle.
EPI.—Epithelium.
H. I.—Hind-intestine.
INT.—Intima.
LU.—Lumen.
MI.—Mid-intestine.
Oes.—Oesophagus.
Oes. V.—Oesophageal Valve.
P. O.—Projection of oesophagus.
P. VLV.—Pyloric Valve.
R. C.—Regenerative cell.
REC.—Rectum.
S. G.—Salivary Gland.
X—Columnar "peritrophic cell."



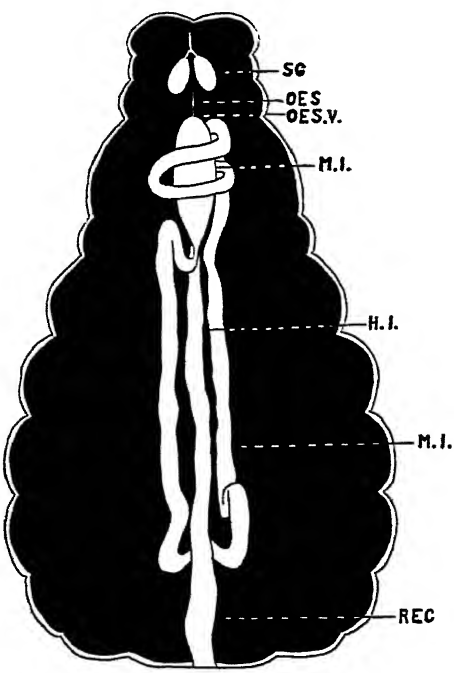
4



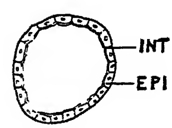
6



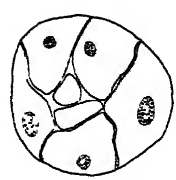
5



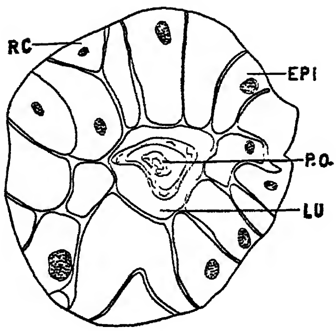
1



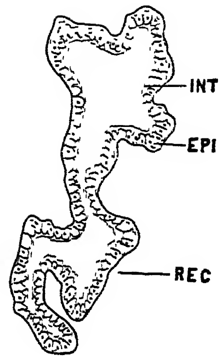
3



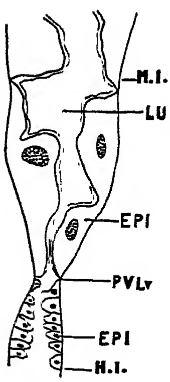
2



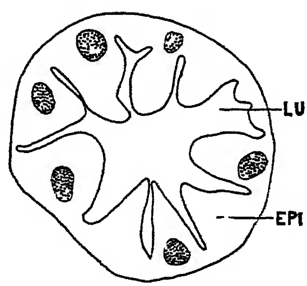
7



10



9



8

LEVEL OR FLAT?

GEORGE D. HUBBARD,
Oberlin College

I have been annoyed sometimes by the use of the words "level" and "flat." They are too frequently used synonymously or at least, flat is too often used where level is the correct word.

This discussion, I think, can be started at a place where all will agree. According to Huxley's Physiography[1] level means parallel with the surface of the sea. Sea level is a familiar term, and, barring many little technical differences as to just what to adopt as sea level for a datum plane in surveying, men will agree with Tarr,[2] Hobbs,[3] and Salisbury[4] that "level is a curved surface." Tarr and Martin[5] make a point in a special paragraph that "sea level is a curved surface, conforming closely to the oblate spheroidal form of the earth." They also state that the ocean floor is in the main level, and they explain that they mean that it is roughly parallel to the surface of the sea—a curved surface. While the matter is not always so clearly and fully stated, in most books in our fields level seems to mean parallel with sea level. In many books too, the earth's surface is said to depart from level by the flattening at the poles, or to be less level, less convex, or less rounded toward the poles.

Some authors point out that "horizontal" is parallel with sea level or the sea surface, or that it is at right angles to the perpendicular. Others say that "level" is at right angles to the perpendicular or to the earth's radius; some add "at right angles to any radius or to all radii."

Dictionary definitions are derived from usage. Webster's International gives literal and figurative definitions and the

---

[1]Physiography, T. H. Huxley and R. A. Gregory, pp. 214–215, 349–350. Macmillan and Company, London, 1905.

[2]The New Physical Geography, R. S. Tarr, pp. 9, 179. The Macmillan Company, New York, 1904.

[3]Earth Features and Their Meaning, W. H. Hobbs, p. 245. The Macmillan Company, New York, 1931.

[4]Physiography, R. D. Salisbury, pp. 400, 707. Henry Holt and Company, New York, 1913.

[5]College Physiography, R. S. Tarr and Lawrence Martin, pp. 640, 644. The Macmillan Company, New York, 1914.

first group all involve horizontality, rectilinearity, or equipotentiality as to gravity.

With this unanimity of usage and definition it ought not to be difficult for physiographers and geologists to be reasonably consistent in the use of "level."

The term "flat" may be made as valuable as "level" has become if we were willing. I turn to the Thesaurus and find the whole discussion of when to use flat centers on flatness as opposed to convexity, protuberance, and roundness. In geometry a flat surface and a plane are used synonymously, and a flat surface can stand in any position with reference to the perpendicular. In usage it has nothing to do with perpendicular, or with horizontal, or with gravitation. It may be as smooth as a level surface but it is not level. It may be thought of at times as tangent to a level surface but never coincident with it.

With reference to drainage, flat and level have meaning. A level surface cannot be drained because it is everywhere at right angles to the perpendicular; there is no grade, no slope, no difference of potential as to gravity. A flat surface of land must be tangent to the sphere or to a level surface at some point. It drains with ease because the potential upon it increases everywhere toward that point of tangency. Suppose the position of a flat surface were that of tangency of the earth, and at right angles to our radius. It could not be at right angles to any other radius. With reference to the earth's surface, the level surface, it would rise on all sides or in all directions from the point of tangency.

Six such flat surfaces tangent to a sphere and placed at radii equally spaced, 90° apart, would constitute a cube. The edges of such flat surfaces inclosing the earth would make dihedral angles of 90°, mountain crests rising 1,300 to 1,400 miles high with slopes of 45°; and the trihedral angles of the circumscribed cube would be still higher. On an earth of the size of ours, bounded by six flat surfaces, our seas, if uniformly distributed, would be six similar deep seas and there could be no communication between the several seas until much leveling had taken place. No doubt gravity would manage most of the leveling.

This study resembles two others that only need to be suggested. The first may be approached by the question, "Do you go uptown or downtown? up to Cleveland or down to Cleveland? up or down to Cincinnati?" In the use of maps

do you describe everything as "up" that is toward the top of the map, or even toward the north? Do you go down the Atlantic coast and down to South America? up to the north pole or Greenland? One might go up or down stream but not up north or down south. Let's get over such unscientific statements.

The second is equally obvious when indicated. Do you say, in pointing to a map illustrating your talk, "The waterfalls are right here?" Why not say, "up the river 9 miles from Columbus." One still might then point to Columbus and Hayden's Falls on the map without affirming that they have been brought into captivity or spread upon the wall.

One might here open the discussion of the use of the terms "plane" and "plain" in physiographic description. If plains are due to degradation or to aggradation most of them are more or less level and not flat. The geometers have reserved "plane" for flat surfaces. Let us let them have it. I do not care to push this point further today, even in the interest of more exact scientific expression.

Electrons for Everybody

Popular books on scientific subjects are enjoying a tremendous vogue these days, and even such abstruse subjects as electronics have not been overlooked. This frankly popular exposition of the electron and its modern wonders will appeal to the layman because of its sheer dramatization of things in which everyone is interested. The story of the attempt—and its gradual success—to unlock the unfathomed sources of energy resident in the nuclei of the atoms of matter is inherently a dramatic one, and from this standpoint it is told well. The applications of electronics to music, radio, television, medicine, surgery and industry are vividly unfolded. The book is just what it claims to be, a popular story of "these amazing electrons."—*L. H. S.*

These Amazing Electrons, by Raymond F. Yates. vii+326 pp. New York, The Macmillan Co. 1937.

Cytological Technique for Plant Breeders

Plant breeders of today are employing methods of the cytologist more frequently, since many breeding problems have been solved by such technics. Unfortunately the practical man too often is overwhelmed and thoroughly discouraged when he attempts to obtain cytological technics from the literature because of inadequate descriptions and a cloak of unfamiliar terminology. This booklet is a worthy attempt at simplifying and concentrating technics usable by the breeder. The text consists of ten pages. A one-page appendix lists formulae for several fixatives. The short bibliography could have been extended profitably.

—*Glenn W. Blaydes.*

An Outline of Cytological Technique for Plant Breeders. Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, England, 1937. Price 1/6.

The Ohio Journal of Science

Vol. XXXVIII JULY, 1938 No. 4

Annual Report

of the

Ohio Academy of Science

Forty-eighth Meeting

1938

TABLE OF CONTENTS

THE OHIO ACADEMY OF SCIENCE

Organized 1891 Incorporated 1892

Affiliated with the American Association for the Advancement of Science

---

OFFICERS AND COMMITTEES FOR 1938–1939

President

CLAUDE E. O'NEAL

Vice-Presidents

A. *Zoology:* R. A. HEFNER
B. *Botany:* PAUL B. SEARS
C. *Geology:* W. S. COLE
D. *Medical Sciences:* L. F. EDWARDS
E. *Psychology:* JAMES R. PATRICK
F. *Phys. and Astronomy:* L. E. SMITH
G. *Geography:* FRED A. CARLSON
H. *Chemistry:* HARVEY V. MOYER
I. *Mathematics:* (To be supplied)

Secretary

WILLIAM H. ALEXANDER

Treasurer

EUGENE VAN CLEEF

Executive Committee

Ex-Officio: CLAUDE E. O'NEAL, WM. H. ALEXANDER, EUGENE VAN CLEEF
Elective: CHARLES G. SHATZER, J. PAUL VISSCHER

Board of Trustees

HERBERT OSBORN, *Chairman*, term expires . 1941
WILLIAM LLOYD EVANS, term expires 1939
JAMES P. PORTER, term expires... 1940

Library Committee

MRS. ETHEL M. MILLER, *Chairman*,
In charge of Academy Exchanges and Publications
W. H. SHIDELER, term expires 1939
GEORGE D. HUBBARD, term expires... 1940

Committee on Conservation

EDWARD S. THOMAS, *Chairman*, term expires 1940
EMERY R. HAYHURST, term expires 1939
EDMUND SECREST, term expires 1939
L. E. HICKS, term expires 1939
F. H. KRECKER, term expires 1940
W. E. STOUT, term expires.. 1940
G. W. CONREY, term expires. 1941
E. L. WICKLIFF, term expires.. 1941
ROBERT B. GORDON, term expires. 1941

Academy Representatives on the Joint Administrative Board, Ohio Journal of Science

EDWARD L. RICE, term expires 1939
WALTER H. BUCHER, term expires.... 1940

Nominating Committee for 1939

A. WARREN P. SPENCER
B. RAYMOND A. DOBBINS
C. JOHN L. RICH
D. DR. BRUCE K. WISEMAN
E. HAROLD E. BURTT, *Chm.*
F. DAYTON C. MILLER
G. FRANK J. WRIGHT
H. W. CONRAD FERNELIUS
I. (To be supplied)

REPORT OF THE FORTY-EIGHTH ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

WILLIAM H. ALEXANDER,

Secretary

The Forty-eighth Annual Meeting of the Ohio Academy of Science was held at the College of Wooster, Wooster, Ohio, on May 6 and 7, 1938, under the presidency of Prof. Charles G. Shatzer, of Wittenberg College, Springfield, Ohio. The College of Wooster, ably assisted by the Ohio Agricultural Experiment Station, made every possible effort to anticipate and provide for the requirements, comfort and pleasure of all visiting scientists and the verdict seemed to be that the meeting was an unusually successful one from every point of view. Thanks to both institutions!

The business portion of the meeting consisted of two short sessions, both held in the Netta Strain Auditorium, Taylor Hall, of the College of Wooster, the first beginning at 9:30 A. M. on Friday, May 6, and the second on Saturday morning.

Very briefly, for economical reasons, the chief items of business transacted at the business sessions were:

I. The announcement by the President of the appointment of the three committees, viz.:
   1. *Membership*—JOHN L. RICH, Chairman; GEORGE D. HUBBARD, D. F. MILLER.
   2. *Resolutions*—EUGENE VAN CLEEF, Chairman; WM. C. BEAVER, J. PAUL VISSCHER.
   3. *Necrology*—HERBERT OSBORN, Chairman; PAUL E. MARTIN, FRANK J. WRIGHT.

II. Reports of Officers.
   1. Secretary.
   2. Treasurer.
   3. Librarian.

III. Reports of Committees.
   1. The Executive, by the Secretary.
   2. Trustees of the Research Fund, by Herbert Osborn.
   3. Membership Committee, by John L. Rich.
   4. Save Outdoor Ohio, by A. E. Waller.
   5. Necrology Committee, by Dr. Herbert Osborn.
   6. Joint Administrative Board, Ohio Journal of Science, by B. S. Meyer.
   7. Resolutions Committee, by Eugene Van Cleef.

IV. Motions Passed.

1. Authorizing the formation of a Section of Mathematics.
2. To co-operate with the Director of Education.
3. As to effective date of the beginning of memberships.
4. Election of representative on the Council of the A. A. A. S., referred to the Executive Committee with power.
5. To meet with the University of Cincinnati in 1939.

V. Amendments Passed.

1. In as much as the duties of the Publications Committee as defined in Article IV of the Constitution have been merged in the duties of the Joint Administrative Board of the Ohio Journal of Science, it is recommended that the Constitution be amended by the omission of Sections 3 and 14 of Article IV. (Rec. by the Exc. Com. Adopted.)
2. *Membership Committee.*—The Membership Committee shall consist of one member from each Section of the Academy, elected by the Section or appointed by the Vice-President of the Section. (Art. IV, Sec. 3, approved as amended.)
3. *Duties of Membership Committee.*—The Membership Committee shall seek to secure new members for the Academy, pass upon the sufficiency of the applications, and make report with recommendation to the Executive Committee or to the Academy. (Art. IV, Sec. 14 approved as amended.)

VI. Resolutions Passed.

1. *Resolved*, That applications for membership approved at the spring meeting be made effective dating from the beginning of the calendar year in which they are approved.
2. *Resolved*, That the business of the Ohio Academy of Science, beginning with the fiscal year 1939-1940 and thereafter, be transacted by a Council. (Rec. by Exec. Com.)
3. *Resolved*, That a committee be appointed by the President to review the Constitution and By-Laws of the Academy and report with recommendations as to changes necessary to comply with the preceding resolution, at the annual meeting in 1939, this resolution to serve as notice to amend. (Rec. by Exec. Com.) (In accordance with said resolution the following were appointed:—F. C. Blake, G. D. Hubbard and F. H. Krecker.)
4. *Resolved*, That a committee on counsel and co-operation in the study of the science needs of the public schools be appointed by the President in 1938-1939, to study the needs of the public school science teachers with reference to their academic preparation and to consult and co-operate with the State Director of Education with a view to offering him any support and assistance at their command. (In accordance with said resolution the following were appointed:—C. G. Shatzer, H. C. Sampson, A. W. Lindsey, L. W. Taylor and W. A. Manuel.)

5. "The Western Society of Naturalists, meeting in Berkeley, California, December 28, 29 and 30, 1937, records its emphatic opposition to any measure such as the proposed 'State Humane Pound Law' which will hinder or curtail animal experimentation as conducted by those fully qualified in biology and medicine. It is the belief of this Society that the present level of health and humane protection of man and animals and further advance in our knowledge of the phenomena of life can be maintained only by constant vigilance and by continued study of the nature of vital processes through the experimental investigation of living animals. Every effort should be made to provide the necessary animals for scientific studies rather than to interfere by the passage of hampering legislation." (Unanimous approval was given this resolution at the request of the California Society for the Promotion of Medical Research.)

   See the reports of the Conservation Committee and the Representative on the Save Outdoor Ohio Council for other resolutions.

There was only one general scientific session of the Academy and that was on Friday morning following the first business meeting. At this general session the Academy had the pleasure of hearing an address on "Heredity and Education," by Dr. Paul Popenoe, the distinguished director of the Institute of Family Relations, Los Angeles, Calif.; also one by State Director of Education E. N. Dietrich, of Columbus, Ohio, on "The Training of Science Teachers."

The annual dinner was not only a festive occasion but a real intellectual treat. The outstanding feature, of course, was the Presidential Address by President Charles G. Shatzer, on "When Are We Scientific." He gave the scientist much food for sober thought. Following the presidential address, Dr. George B. Barbour, of the University of Cincinnati, showed a color film of "Vesuvius in Eruption." In addition to these addresses, there was the usual exchange of courtesies, President Charles F. Wishart, of the College of Wooster, and Director Edmund Secrest, of the Ohio Agricultural Experiment Station, extending gracious words of cordial welcome and good wishes, to which Dr. Dayton C. Miller, of Case School of Applied Science, Cleveland, made a happy response appropriately interpreting the feelings of every member of the Academy present on that delightful occasion.

And so by common consent the forty-eighth annual meeting was one of the most successful the Academy has ever held and very likely all who attended are already dreaming of a return visit!

A very complete, detailed (stenographic) report of this meeting is on file in the office of the Secretary.

Report of the Secretary

WOOSTER, OHIO, May 6, 1938.

To the Ohio Academy of Science:

As in former years, the office of the Secretary has endeavored most diligently to look after the interests of the Academy with efficiency and despatch. We wish once again to record our high appreciation of the fine spirit of co-operation displayed at all times both by officers and members. We have co-operated in every possible way with the Treasurer in his fine efforts to secure new members for the Academy and while we had hoped to report one hundred or more, we are glad to report a half-a-hundred or more. The roll of members has been thoroughly purged and we now have something like 500 active members. With the approach of our semi-centennial year, the campaign for new members should go on with increased vigor. A goal of 1,000 members by 1940 is not at all unreasonable and should be our minimum. In a State with some 60 colleges and universities to draw upon, the Ohio Academy might easily become the largest in the country.

The Secretary attended all the sessions of the Council of the A. A. A. S. at Indianapolis, Ind., last December, and all the meetings of the Academy Conference. Our chief service to the Academy at this meeting of the A. A. A. S. was, perhaps, in clearing the way for a slightly increased allowance for research, we hope, when these funds are distributed.

One item of interest to report is the securing of some of the original minute books, papers and pamphlets, etc., found among the effects of the late Prof. L. B. Walton, through the courtesy of Mrs. Walton. These will be useful to the Committee on Historical Statistics and Lists, in connection with the Semi-Centennial. It may not be out of place to observe at this point that if we are to make this observance all it might be and we hope it will be, every member must put his or her shoulder to the wheel and give those who undertake to lead us a united, hearty support from the very start.

Respectfully submitted,

WM. H. ALEXANDER,
Secretary.

Report of the Treasurer

To the Ohio Academy of Science:

Statement of Income and Expense for the year ended December 31, 1937.

INCOME:		
Membership Dues		$ 965 00
Grants for Research from A. A. A. S		275 00
Interest on Bonds		78 00
Sale of Publications		24 18
Dinner Receipts		245 00
Total Income		$1,587 18
EXPENDITURES:		
Faculty Club Dinner Expense	$274 69	
Speakers	50 00	
Clerical Assistance	51 00	
Postage and Telegraph	37 85	
Office Supplies	5 90	
Expenses of Officers to Meetings	87 06	
Printing:		
Proceedings, Ohio Journal of Science	130 40	
Other	140.34	
Subscriptions, Ohio Journal of Science	501 00	
Membership, Save Outdoor Ohio Council	8 00	
Research Grants	175 00	
Secretary's Honorarium	100 00	
Safety Deposit Box	3.30	
Auditing Expense	3 00	
Reporter for 1937 Meeting	7 00	
Bank Charges	6 09	
Total Expenditures		1,580 63
Net Increase in Net Worth for the Year		$ 6 55

BALANCE SHEET

As at December 31, 1937

ASSETS

Current Expense Fund:		
Cash in Bank		$ 191 96
Bonds—Consolidated Federal Farm Loan 3%, 1945–55		1,300 00
Total Current Expense Fund		$1,491 96
Research Fund:*		
Cash on Deposit	$ 247 27	
Banc Ohio Securities Company Stock (at cost)	437 50	
Bonds—Fort Hayes Hotel, Columbus (at cost)	1,300 00	
Total Research Fund		1,984 77
Total Assets		$3,476 73

LIABILITIES AND NET WORTH

Liabilities	None
Net Worth—Ohio Academy of Science	$3,476 73
Total Liabilities and Net Worth	$3,476.73

*These funds are not in the custody of the Treasurer.

Respectfully submitted,

EUGENE VAN CLEEF,
Treasurer.

Report of the Auditor

To the Ohio Academy of Science:

I have examined the accounts and records of the Ohio Academy of Science for the periods January 1–May 28, 1937; May 28–December 31, 1937, and I hereby certify that in my opinion the accompanying statements of cash receipts and disbursements, and the attached Balance Sheet presents the financial condition as at December 31, 1937.

Respectfully submitted,

D. M. SHONTING,
Public Accountant.

Report of the Board of Trustees, Research Fund

To the Ohio Academy of Science:

During the past fiscal year there have been additions to the Fund of $71.00 from interest and dividends, so that the amount subject to check was $247.27 on December 31, 1937. A statement for the fiscal year, ending December 31, 1937, is as follows:

RECEIPTS	
Balance on hand December 31, 1937	$ 177 02
Received from Interest and Dividends	71 00
Total	$ 248 02
DISBURSEMENTS	
Service Charge, Ohio National Bank	$ 75
Balance on hand, Checking Account	247.27
Total	$ 248 02
No changes have been made in investments.	
Bonds at Face	$1,300 00
Stock, Ohio National Bank, at Cost	437 50
Total Invested	$1,737 50
Balance on Deposit, Checking Account	247 27
Total Assets	$1,984 77

Receipts since December 31, 1937, are $36.50, less service charge leaves us a checking account of $283.52. No grants have been charged to this account the past year.

By action of the Executive Committee the Board was authorized to assign the allowance coming from the A. A. A. S. and the following grants were alloted, the items being carried in the Treasurer's account:

To Dr. D. C. Rife, Ohio State University, for genetic studies of monozygotic twins and other multiple births, $75.00.

To Mr. Wayne M. Felts, Cincinnati University, for research on an acid intrusive in the Cascade Mountains of Southwestern Washington, $100.00.

To Dr. R. A. Dobbins, Ohio Northern University, for Vegetation of the northern 'Virginia Military Lands' of Ohio, $100.00.

These requests were accompanied by ample endorsements by Academy members and the allotments have been reported to the Permanent Secretary of the A. A. A. S. for his information and record.

As we may expect another allowance from the American Association which it is desirable to allot without delay and as we have a balance from which some grants may be made we will be pleased to receive applications and to act upon them without delay.

Respectfully submitted,

HERBERT OSBORN, *Chairman*,
WM. LLOYD EVANS,
Trustees.

Report of the Executive Committee

By the Secretary

WOOSTER, OHIO, May 6, 1938.

To the Ohio Academy of Science:

Your committee has held two well-attended meetings for the transaction of Academy business during the year: one on December 18, 1937, in the office of the Treasurer, and the other last evening at the Ohio Hotel, Wooster, Ohio.

At the first meeting, the chief items of business transacted were: (1) The approval of five applications for membership in the Academy; (2) the approval of the payment of $175.00 from the Research Fund for approved projects; (3) the authorization of the purchase of books for the use of the Treasurer, not to exceed $25.00 in cost; (4) the approval of a membership campaign as outlined by the Treasurer; (5) approval of the purchase of certain lands known as "Fort Hill" and "Cedar Swamp" for State park purposes, the Secretary being instructed to so advise the Governor and certain other members of the General Assembly; (6) elected the Secretary to represent the Academy on the Council of the American Association for the Advancement of Science and at the Conference of State Academies; (7) the fixing of the date of the next annual meeting of the Academy for May 6 and 7, 1938; (8) an allowance of $15.00, or as much thereof as necessary, was voted for each Vice-President and the same amount for a stenographer at the annual meeting; (9) the election of the following persons in accordance with Item No. 10 of the preliminary report on the semi-centennial as chairmen of Group A Committees:

(1) *Publicity*—EDWARD S. THOMAS, Ohio State University.
(2) *Program*—CLARENCE H. KENNEDY, Ohio State University.
(3) *Speakers*—FRANK J. WRIGHT, Denison University.
(4) *Invitations*—(To be supplied later).
(5) *Historical Statistics and Lists*—SAMUEL RENSHAW, Ohio State University.

At the second meeting, it was voted: (1) to approve and recommend the election of 52 new applications; (2) to recommend the approval of certain amendments to the Constitution and By-Laws; (3) to recom-

mend that the Academy go on record as favoring the council form of government in the transaction of its business and that a committee be appointed to suggest the necessary changes in the Constitution at the next annual meeting; (4) to approve the petition of 17 members for the formation of a Section of Mathematics; (5) to recommend that an extension of time be given the Nominating Committee for the selection of a Director for the semi-centennial; (6) to recommend that the Academy accept the invitation of the University of Cincinnati to hold the 1939 annual meeting at that institution.

Report of the Committee on the Election of Fellows

WOOSTER, OHIO, May 6, 1938.

To the Ohio Academy of Science:

The Committee on the Election of Fellows in the Ohio Academy of Science, consisting, as you know, of the officers of the Academy and the Vice-Presidents of the Sections, met this morning at the College of Wooster and elevated the following members to the rank of Fellows in the Ohio Academy of Science, viz.:

DR. FRED A. CARLSON	Ohio State University
DR. RAYMOND ANSON DOBBINS	Ohio Northern University
DR. ROBERT ARTHUR HEFNER	Miami University
DR. WALTER C. MCNELLY	Miami University
DR. JOHN J. WOLFORD	Miami University

Respectfully submitted,

WM. H. ALEXANDER,
Secretary.

Report of the Joint Administrative Board of the Ohio Journal of Science

COLUMBUS, OHIO, May 4, 1938.

To the Ohio Academy of Science:

The meeting of the Joint Administrative Board was held at Ohio Wesleyan University, Delaware, Ohio, on April 16, 1938. Present were all members of the Board, the Editor and the Business Manager. The meeting was called to order by Chairman Rice at about 1:00 P. M. The minutes of the preceding meeting were read and approved.

Upon motion, the terms of all present officers were continued for the year 1938. Both the Editor and the Business Manager informed the Board that they did not care to have their terms of office prolonged beyond ten years, and it was suggested that it would be desirable for the Board to begin to look for persons qualified to fill these offices.

The Business Manager presented his financial report as follows:

RECEIPTS

Balance from 1936	$ 247 92
University Allowance	750 00
Ohio Academy of Science, Dues	598 50
Ohio Academy of Science, Publication of Proceedings	191 59
Sigma Xi, Special Grant	299 27

Subscriptions	83 50
Author's Payments for Plates	161 68
Sale of Back Numbers	6 50
	$2,338 96

EXPENDITURES

Spahr & Glenn Co., Printing Vol. 36, No. 5	$ 249 50
Spahr & Glenn Co., Printing Vol. 37, Nos. 1-5	1,195 62
Spahr & Glenn Co., Envelopes	62.50
Postmaster	141 80
Bucher Engraving Co	249 09
Clerical Assistance	3 25
	$1,901 76
Balance on hand Feb. 26, 1938 (Huntington National Bank)	437.20
	$2,338 96

As of this date bill for November, 1937 number of the Journal, amounting to $497.17, is unpaid. All other 1937 bills are paid.

Upon motion this report was accepted and placed on file. Dr. Transeau was appointed a committee of one to audit the Business Manager's report.

The meeting adjourned about 3:00 P. M.

Respectfully submitted,

B. S. MEYER,
Secretary.

Report of the Library Committee

COLUMBUS, OHIO, April 27, 1938.

To the Ohio Academy of Science:

The members of the Library Committee were much saddened at the loss of one of its members, Dr. L. B. Walton, who died the day after he had been re-appointed to the committee for another three-year term. A biographical sketch of him will be given by the Necrology Committee.

The work of the chairman of this library committee has been of the customary routine nature, such as taking care of the correspondence, of the sales of publications and the mailing list, claiming issues of periodicals that somehow had failed to arrive and posting out issues of our journal when requested. In addition the stock of last year's Ohio Journal of Science was assembled into volumes, wrapped and stored in the Ohio State University Library. Just before the first number of the 1938 volume of the Journal was issued the mailing list was checked with that of the Treasurer of the Academy and also with the official list in the mailing room.

Five new exchanges were secured during the year and fourteen were dropped. The total number of exchanges is now 362, of which 95 are in this country and 267 in foreign countries.

The sales of publications amounted to only $22.39. Eighteen sales were made and thirty-four Special Papers were sold, but none of the Annual Reports. Five of these eighteen sales were made to

book dealers who purchased fourteen items or nearly half of all that were sold and who furnished one-third of the entire sales amount. A change in policy accounted for this increase in sales to dealers. In former years they received no discount, hence there was no incentive to purchase any papers. However, as the stock of all of the Reports and of most of the Special Papers is large and as only two have been published later than 1912, it was decided by the library committee to allow a ten per cent discount to dealers and thus to increase the sales if possible. If this had not been done the sales for 1937 would have consisted of only twenty items at the very small total of $14.70. The sum of $22.39 plus 29 cents sales tax has been given to the Treasurer of the Academy.

At the end of 1937 the sum on deposit in the building and loan company amounted to $32.25. This amount plus $4.75 which had previously been paid to the Treasurer, or $37.00, represented the total dividends earned by the various sums which had been deposited in the five and a half years from June, 1926, to January, 1932. On January 18, 1938, this account was closed and the entire amount was given to the Treasurer of the Academy.

In accordance with the policy of the last few years, no formal financial statement is given in this report, but it has been duly made and is on file for the purpose of record in the office of the Treasurer and also in the library of the chairman of this committee.

The privilege of borrowing books from the Ohio State University Library is called again to the attention of the members of the Academy, for it has been five years since this was done, and many new members have joined during this time. Some of the other members also do not seem to realize that they are entitled to draw out books as individuals if they live at a distance from a college or university. For those who are associated with an institution it is preferred that they borrow books through their own library on the inter-library loan plan. There is much material in the library of the Ohio State University that surely could be of value to the members of the Ohio Academy of Science if they would make use of it.

Respectfully submitted,

ETHEL MELSHEIMER MILLER,
Chairman.

Report of the Membership Committee

WOOSTER, OHIO, May 7, 1938.

To the Ohio Academy of Science:

Applications for membership in the Academy properly countersigned and accompanied by one year's dues were received by your committee from the following persons whose election to membership we cordially recommend, viz.:

AMSTUTZ, MARY E., (A), 410 Pleasant St., Ashland.
ARENSON, S. B., (H), University of Cincinnati, Cincinnati.
BARNES, HUGHES, (A and B), 202 N. Uhrich St., Uhrichsville.

BERNHAGEN, RALPH J., (C), O. S. U., Columbus.
BLACKBURN, N. D., (A), O. S. U., Columbus.
BOSSERT, ROY G., (H), O. W. U., Delaware.
BRAND, PAUL J., (G), 1683 Biddle St., Ravenna.
BUSCH, KARL HENRY, (A), 2424 Sherwood Rd., Bexley.
BUSCH, HARVEY L., (A), 1596 Parkwood Rd., Lakewood.
CAMPBELL, F. L., (A, D and H), 1952 Concord Rd., Columbus.
CATALINE, ELMON L., (D and H), University of Toledo, Toledo.
CHITTAM, JOHN W., (H), College of Wooster, Wooster.
CRIST, EMMITT L., (B), I. O. O. F. Bldg., Circleville.
CROWL, GORDON S., (B), O. S. U., Botany Dept., Columbus.
DEMARINIS, FRANK, (A), 2170 Stillman Rd., Cleveland Heights.
DEXTER, RALPH W., (A and B), Kent State University, Kent.
DUNGAN, THEODORE C., (E and F), 83 Sixteenth Ave., Columbus.
ELSASS, DONALD H., (A and H), 670 Vernon Rd., Bexley.
ERF, HERBERT A., (F), 16827 Fernway Rd., Shaker Heights.
GRADY, ROY I., (H), College of Wooster, Wooster.
FROMM, GUY, (F), Capital University, Columbus.
HAMILTON, DR. FRANK E., (D), Kinsman Hall, O. S. U., Columbus.
HERRICK, J. ARTHUR, (A and B), Kent State University, Kent
HESKETT, CLARENCE, (G), O. S. U., Columbus.
HOKE, ROY DAVIS, (C and F), 1750 S. Union Ave., Alliance.
HOUSLEY, C. R., (A and B), R. F. D. No 1, Pemberville
HOWLETT, FREEMAN S., (B), 357 Blessing Ave., Wooster.
JONES, CLYDE H., (B), 34 W. Norwich Ave., Columbus.
KARNES, LOWRY B., (G and C), 488 W. Seventh Ave., Columbus.
KNOX, GEORGE, (E and F), O. S. U., Columbus.
LACKEY, JAMES B., (A), Third and Kilgour Sts., Cincinnati
LAMBERT, RAY, (F), 3422 Woodburn Ave., Cincinnati.
LAPHAM, MARJORIE J., (A), 40 E South St., Painesville.
LEDGERWOOD, RICHARD, (E, D and A), 1864 Summit St., Columbus
MACHLE, DR. WILLARD, (D), College of Medicine, Cincinnati.
MAHARRY, JOHN P., (G, C and F), 413 W. Warren St., Youngstown.
MASON, HELEN MANDILLA, (B), R. F. D. No. 4, Newark.
MAYFIELD, SAMUEL M., (C and G), Bowling Green State Univ., Bowling Green.
MILLER, EUGENE J., (C and G), Loudonville Times, Loudonville.
MOKE, CHARLES B., (C), College of Wooster, Wooster.
MYERS, R. MAURICE, (B), O. S. U., Dept. of Botany, Columbus.
NOLAN, ALFRED FRANCIS, (D), 40 Brevort Rd., Columbus.
PALINCHAK, STEVE, (H, F and I), 2546 Auburn Ave., Cincinnati.
PORTER, WALTER P., (B and A), 135 Grosvenor St., Athens.
POWELL, G. W. H., (H, F, A and I), Urbana Junior College, Urbana.
RAY, FRANCIS E., (H), University of Cincinnati, Cincinnati.
RICHARDS, C. F., (E), Denison University, Granville.
RIEVESCHL, GEORGE, JR., (H, F and I), 112 Mill St., Lockland.
RIFE, D. C., (B and A), 1483 N. Star Rd., Columbus.
ROSZMAN, FOSTER D., (A), Bowling Green Univ., Bowling Green.
SALETEL, DR. LOUIS, (C), University of Dayton, Dayton.
SCHWARZBEK, WM., (E), Wittenberg College, Springfield.
SCOFIELD, EDWARD H., (E), Columbus.
SEAMAN, ELWOOD A., (A and B), 1368 Beall Ave., Wooster.
SHILLING, E. R., JR., (B and A), Kent State University, Kent.
SOLBERG, ARCHIE N., (D), University of Toledo, Toledo.
SOUTHWICK, ERMAN DEAN, (C), Mt. Union College, Alliance
STEIDTMANN, WALDO E., (B), Bowling Green State Univ., Bowling Green.
THOMPSON, ISABEL, (B), 3317 Jefferson Ave., Apt. 21, Cincinnati.
WALLACE, ATWELL M., (B, H and C), 232 W. Lane Ave., Columbus.
YOCUM, DR. LINCOLN A., (D), Wooster.

Respectfully submitted,

JOHN L. RICH, *Chm.*
GEORGE D. HUBBARD
D. F. MILLER

Report of Dr. A. E. Waller, Academy Representative on the "Save Outdoor Ohio" Council

WOOSTER, OHIO, May 7, 1938.

To the Ohio Academy of Science:

For the first time in Ohio's history, we are presented with the possibility of developing the Lake Erie shore to make it available for the use of the people of Ohio.

The Ohio legislature, in special session February 28, 1938, adopted a resolution memorializing the Conservation Council to purchase lands as sites for the establishment of state parks along the shores of Lake Erie for conservation and recreation purposes. The resolution provided for the appointment of a committee, with expenses to be paid from legislature committee funds, to make a study of suitable areas on the shore of Lake Erie, and report back to the legislature at any special session.

Governor Martin L. Davey, in a radio address March 24, stated: "It is surprising that Ohio is the only state bordering on the Great Lakes that does not provide park facilities for its people. In fact, our public parks are pitifully inadequate, and if we are to do a really good job, this state must start soon to revise its policy and program with reference to public parks. . . . This, I believe, should be the next great forward step."

The sentiment expressed in the legislature's resolution and in Governor Davey's radio address is well founded. The state of Ohio does not own a single square foot of land on the shore of Lake Erie which can be used for conservation or recreational purposes. Other adjoining states have developed elaborate park systems for the citizens of their states, and in most cases these states have less natural advantages than Ohio.

The Save Outdoor Ohio Council, supported by a number of statewide organizations interested in the conservation of our natural resources and restoring our wild life, is sponsoring a land-acquisition program for the purpose of establishing and developing a series of state parks along the shores of Lake Erie.

Approval by the Academy of the following resolution is heartily recommended, viz.:

WHEREAS, There are no state park facilities on the shores of Lake Erie for wildlife conservation and recreational purposes; and

WHEREAS, The establishment of state parks on the shores of Lake Erie would provide conservation and recreational facilities for the people of our state;

Therefore, be it Resolved, by the Ohio Academy of Science, that the Conservation Council of Ohio is urged to develop a Lake Erie State Park Program, and that the members of the Legislature of Ohio be requested to pass necessary legislation appropriating funds to purchase lands as sites for the establishment of State Parks along the shores of Lake Erie for conservation and recreational purposes.

Be it further Resolved, That any such parks developed on the shores of Lake Erie shall be known temporarily as Lake Erie State Park No. 1, Lake Erie State Park No. 2, Lake Erie State Park No. 3, etc., in order that they may be widely presented and promoted as conservation and recreational areas for the use of the people of Ohio. (Approved)

Report of the Committee on Necrology

To the Ohio Academy of Science:

It becomes the sad duty of your committee to record the death during the past year of five of the prominent members of the Academy. With the material available it has been difficult to give adequate tributes to their service in the Academy or the measure of their contribution to science.

Only a few days after the close of our last year's meeting we were shocked by news of the sudden death of Dr. Walton, of Kenyon College.

Lee Barker Walton

Lee Barker Walton, born at Bear Lake, Pennsylvania, November 12, 1871, died at Gambier May 12, 1937. His connection with the Ohio Academy dated from his first year of service as Professor of Biology at Kenyon College, 1902, and he has been one of our most loyal and useful members in the succeeding years. He served as secretary from 1905 to 1912 and as president in 1913. He has also been a valued member of a number of important committees and was one of the Trustees of the Research Fund for several years, 1930 to 1936.

Dr. Walton was a man of varied interests and aside from his important contributions in biology was influential in the promotion of athletics and was fond of games and social contacts. He was an exceptional teacher and inspired many young men to go forward in biological studies especially in medicine. He spent the summers of 1905–'06–'07 and '09 at the Lake Laboratory and was a contributor to the Ohio Biological Survey. His valuable articles on "Euglenoidea of Ohio" and "Studies of Organisms in Water Supplies" are in demand from many quarters outside of Ohio. His genial companionship and stimulating personality will be greatly missed by a large circle of friends.

Joseph A. Culler

Dr. Joseph A. Culler, who died May 18, 1937, was for many years a professor at Miami University and Dr. S. R. Williams, a long time associate and friend, has furnished the following tribute:

"Dr. Joseph A. Culler was born in Wayne County, Ohio, March 5, 1858, and died at the Miami University hospital in Oxford May 18, 1937, in his eightieth year. He received the A.B. in 1884 and the Ph.D. in 1900, both degrees from Wooster College. His wife, Isabella Carnes, who survives him, also attended Wooster.

"Dr. Culler was principal of the high school in Cambridge, Ohio, the year 1884–85 and of the high school in Kenton from 1889 to 1900 and in Bowling Green from 1900 to 1903.

"In 1903 he was called to the chair of Physics in Miami University and retired from active service in 1926 because of the serious results of X-ray burns received during experimental work. Dr. Culler was quiet and reserved so that one had to become acquainted with him to appreciate his many-sided abilities. During his undergraduate course he directed the early gymnasium classes at Wooster and through his secondary school teaching, in addition to his special work in physics, he found the time to write a graded series of texts in physiology with many original illustrations.

"In college he prepared his own text book and set of laboratory directions for the introductory physics course and many of the advanced texts. His style was terse, simple and easily comprehended. His demonstrations of physical phenomena were carefully planned and with details thoroughly worked out so that the interest of the hearers never waned. He was an inspiring and painstaking teacher, experienced in the difficulties and discouragements of the young. His time and assistance were freely available for any one in need whether student, faculty or townsman.

"He was for many years on the Board of Public Affairs of the village of Oxford. He was a member of the Beta Theta Pi college fraternity and of the Masonic order. A life-long member of the Presbyterian church, he taught a men's class in the Sunday School and as long as he was physically able. His younger colleagues, especially those working in the same building, regularly relied on his manipulative ability to straighten out refractory apparatus and much more on his judgment and friendly advice to straighten out unfortunate kinks in their lives."

John M. Condrin

In the death of John M. Condrin, of Toledo University, the Academy has lost one of its very promising young members. He joined the Academy in 1927 and his activities in research gave promise of valuable contributions in his chosen field. The following obituary notice in *Science* by his associate and friend seems especially appropriate in this connection:

"John M. Condrin, associate professor in the department of biology of the University of Toledo, died on June 9 [1937] at the age of thirty-two years. Professor H. H. M. Bowman, in whose department he was an associate, writes: 'He had been a member of the department since 1927. He was a graduate of Western Reserve University and received the M.A. degree from that institution in 1927 and was just completing work for his doctorate at the University of Michigan. He was a member of several national zoological societies and of both the Ohio and Michigan Academies of Science. He was the author of several publications on nudibranchs, genetics of pigments in mollusks and the physiology of hibernation in mammals. We will sorely miss his pleasant, active presence and scientific co-operative spirit.' "

Rodney D. Book

Dr. Rodney D. Book, Corning, Ohio, who was a member of the Academy from 1933, died November 6, 1937. From notices published

at the time we glean the following items which bear upon his connection with the Academy:

Dr. Book was an ardent student of bird life and lectured extensively on this subject, and his death from pneumonia was said to have followed attendance of the National Audubon Society convention in New York City two weeks before his death. He is credited with several books on music and with musical compositions, these activities and his bird studies being secondary to his practice as a physician. He was a graduate of the Kentucky School of Medicine, the New Church Theological School of Cambridge, Mass., and the Cincinnati College of Music. His medical practice began at Corning in 1892 and continued until his death.

RICHARD E. WOLFE

Dr. Raymond Osburn has from his personal friendship with Mr. Wolfe supplied the following:

Mr. Richard E. Wolfe, of Clyde, Ohio, died suddenly during the December holidays of 1936-37. He became a member of the Academy in 1929 and continued until his untimely death. His college work was done at the Ohio State University, where he was granted the degree of B.E. in 1926. The summers of 1929-30-31 were spent at the Franz Theodore Stone Laboratory at Put-in-Bay, where he completed the work for the M.Sc. degree in zoology in 1931. His Master's thesis was the result of a very careful study of the ecology of the Miller Blue Hole (now State property) some six miles west of the better known Castalia Blue Hole. In this work his knowledge of chemistry as well as aquatic biology was a distinct asset. For ten years Mr. Wolfe had taught chemistry and biology in the high school of his home town and was held in high esteem, not only for the high grade of his work as a teacher, but also for his sterling character and genial personality.

Respectfully submitted,

HERBERT OSBORN,
FRANK J. WRIGHT,
Committee.

Report of the Nominating Committee

For President.............................. CLAUDE E. O'NEAL
For Vice-Presidents—
A. Zoology.............................. ROBERT A. HEFNER
B. Botany.............................. PAUL B. SEARS
C. Geology.............................. W. STORRS COLE
D. Medical Sciences.............................. L. F. EDWARDS
E. Psychology.............................. JAMES R. PATRICK
F. Physics and Astronomy.............................. LEON E. SMITH
G. Geography.............................. FRED A. CARLSON
H. Chemistry.............................. HARVEY V. MOYER
For Secretary.............................. WILLIAM H. ALEXANDER
For Treasurer.............................. EUGENE VAN CLEEF
For Executive Committee.............................. CHARLES G. SHATZER
J. PAUL VISSCHER

For Trustee, Research Fund...... .. ..HERBERT OSBORN
For Administrative Board, O. J. S.. . . ..WALTER H. BUCHER
For Library Committee................... ....GEORGE D. HUBBARD
For Committee on Conservation .... G. W. CONREY, E. L. WICKLIFF, ROBERT B GORDON
For Representative on Save Outdoor Ohio Council......A. E. WALLER

As to the Director for the Semi-Centennial, your committee can only report "progress" We have made a very careful canvass of the entire membership list and by a process of elimination have reduced it to some seven or eight names of persons whom we believe to be entirely eligible for the position. We therefore ask the privilege of passing this list on to the new Nominating Committee and in view of the many rather elusive considerations involved recommend that this committee be given more time with power.

Respectfully submitted,

A. W. LINDSEY,
Chairman.

A motion prevailed that the nomination of a Director be referred to the new Nominating Committee with power and instructions "to make the appointment within six months if possible."

Report of the Committee on Resolutions

WOOSTER, OHIO, May 7, 1938.

To the Ohio Academy of Science:

The Committee on Resolutions submits the following conclusions for your approval, viz.:

Resolved, That the members of the Academy express their appreciation to President Wishart and staff of the College of Wooster, and to Director Secrest and staff of the Ohio Agricultural Experiment Station, for making available such excellent facilities for the meeting; and

Be it further Resolved, That the Academy indicate its indebtedness to the local committees under the efficient leadership of Dr. Karl Ver Steeg, chairman, for their untiring efforts in arranging details for the effective conduct of the general and special sessions, and for the satisfactory housing of the out-of-town guests; and

Be it further Resolved, That the members of the Academy, especially the men, extend a vote of thanks to the local committee, and to Mr. and Mrs. Edmund Secrest in particular, for providing delightful entertainment for the ladies; and finally,

Be it further Resolved, That the Academy express its pleasure in the interest shown by the public press of Wooster and other centers as evidenced by the publicity given the proceedings of the meeting.

Respectfully submitted,

EUGENE VAN CLEEF, *Chairman*,
WILLIAM C. BEAVER,
J. PAUL VISSCHER.

Report of the Committee on Conservation

WOOSTER, OHIO, May 6, 1938.

To the Ohio Academy of Science:

Your Committee on Conservation begs to submit the following report of conservation activities in Ohio during the past year.

Soil Conservation—The land resources of Ohio are used chiefly for crops, grass and forests. The purpose for which each area can best be used can be determined only by a study of the conditions existing in different parts of the State. The adoption of a program of soil conservation based on these studies can be brought about by a systematic educational program.

Our present system of crop production leads to soil deterioration. This trend has been expressed by means of a mathematical formula which properly evaluates all forces having to do with soil improvement and soil deterioration—this includes credits for the use of fertilizer and manure, and debits for uncontrolled erosion. Where, at present, the productivity balance is negative (indicating soil deterioration) it is possible, by means of a change in cropping system, to secure a favorable balance resulting in conservation of the soil.[1]

As a part of the educational program of the Extension Service of the Ohio State University, county agricultural planning committees composed of representative farmers have been organized in each county of the State. These committees have studied the local situation and determined what changes in cropping systems would be desirable from the standpoint of soil conservation. Following the reports of these committees a program of soil conservation has been discussed with the groups of farmers in each county, and recommendations for changes in cropping systems have been made. In order to show the effects of these practices, a number of farms have been selected, so far in 32 counties, on which the recommendations are being carried out. In some cases this program is in co-operation with the Soil Conservation Service.

The Soil Conservation Service has four demonstration areas in which erosion control measures are being practised in co-operation with farmers. Under the direction of this Service, 11 CCC Camps are carrying out a program of soil conservation for the control of erosion on individual farms outside of the demonstration areas.

The research program for soil conservation includes the work of the Ohio Agricultural Experiment Station and the Soil Conservation Service. The Ohio Agricultural Experiment Station is engaged in making detailed soil surveys by counties, in order to secure information in regard to soil conditions in all parts of the State. Investigations of the effect of crop rotations and the use of fertilizer, manure and lime are being carried out on the main Station farm at Wooster, and in 13 outlying farms.

---

[1]*See* "Our Heritage the Soil" by R. M. Salter, Ohio Agricultural Experiment Station.

The Soil and Water Conservation Experiment Station at Zanesville, operated by the Soil Conservation Service, is investigating the rate of soil loss under various cropping systems and the effect of different soil conservation measures such as strip cropping, terracing, etc., in the control of erosion.

The Hydrological Experiment Station at Coshocton is studying what happens to the rainfall in runoff, percolation, evaporation and transpiration; the effect of erosion control measures on the losses of water; and the effect of this loss on flood control.

These investigations will serve as a basis for planning for the soil conservation in Ohio. Through the educational work of the Extension Service, the program will be carried to the farmers.

Sealing Abandoned Coal Mines—Report from the Engineering Division of the Ohio Department of Health states that the work of sealing abandoned coal mines in Ohio, to reduce stream pollution caused by acid mine drainage, has continued since its inception in December, 1933. Abandoned mines have now been sealed in 24 counties with funds provided by the federal government through CWA, ERA, and later WPA. During the year 1937, 11,638 mine openings were closed at a total cost to the federal government of $436,270.11, or $37.49 per opening. Of this total cost, $389,493.63, or 89.3 per cent, was expended for labor; $9,133.54, or 2.1 per cent, for materials; and $37,642.94, or 8.6 per cent, for engineering supervision and statistical records. The total number of openings closed to April 1, 1938, is approximately 34,000.

During the year 1937, 6,532 mine drainage samples were collected and analyzed in the Health Department Laboratory. Of 734 mines closed in 1937, the average number of openings was 16.3 per mine. The original acid drainage per mine in tons per year was 82.27. The construction cost per year per ton-original-acid was $6.82. Up to November 1, 1937, the records of 566 mines showed reduction of their acid drainage content amounted to 28,560.39 tons, or 55.6 per cent per year.

On April 1, 1938, 1,820 men were at active work under WPA on this project which was being carried on in 20 counties. The program has been practically completed in Carroll, Mahoning, Meigs, Morgan, and Wayne counties. During 1937, 13 persons were given regular employment on the engineering supervision and statistical staff.

Exhibits of mine sealing work were shown in five leading cities in the state during the year (twice in Athens). A great amount of newspaper publicity was also obtained. The work will be continued to near completion in 1938. However, a continuing program on a smaller scale will be necessary because of the continual abandoning of openings and for constant supervision to assure that old sealings remain intact.

Department of Forestry—The Ohio Department of Forestry is furnishing fire protection to one million acres of forest land. There are an additional million acres which are not receiving protection due to insufficient funds. This includes several areas in eastern and northeastern Ohio and approximately 150 square miles south and west of Toledo.

This Department is administering eight state forests and three state forest parks. These areas are visited by one-half million people annually, and on many of the tracts the chief activity of the ranger is the supervision of public use areas.

Six CCC camps remain in operation on the state forests. They are located one each in the following forests: Shawnee, Scioto Trail, Hocking, Zaleski, Mohican, and Bryan Park.

The Guy B. Findley State Forest at Wellington has been increased by gift to 890 acres. Mr. Hugh Taylor Birch has given four tracts of land which adjoin the John Bryan Forest Park as a memorial to Edward Orton. About 3,000 acres of state forest land have been acquired during the past year.

Tree distribution from the Department's nurseries will amount to approximately five million trees. Most of the trees have been used by farmers to reforest idle land.

One man who was added to the technical staff last October is devoting his time to research in farm woods. The Department is also conducting research in its forest arboretum at the Experiment Station and doing a considerable amount of personal service work with individuals and organizations throughout the State.

The Forest Tax Law which is administered by this Department, involves the part time duty of one forester.

Division of Conservation—During the past year the Division of Conservation has enlarged its fish and game management activities by dividing the State into seven game management districts and eleven fish management districts and placing a technical man in charge of each.

Wildlife management in the form of "cropping" the land and water is being stressed as the best solution to the wildlife problem. Law enforcement and artificial propagation are receiving attention, but the relatively new conservation technique, "Management," is due to grow rapidly in the future.

Ohio Wildlife Research Station—The Ohio Wildlife Research Station, co-operatively maintained by the Ohio State University, the Ohio Division of Conservation and the United States Biological Survey, is now in its third year. Its main office is on the Ohio State University campus, but much of the work is done at eight substations located in various biological units of the State.

The chief objectives are basic fact finding necessary for the conservation and development of the wildlife resources of Ohio, the training of skilled personnel competent to administer these resources, and demonstration and education projects leading to proper appreciation, management and utilization of them. To attain these objectives, a major research program is in progress, with research problems on Hungarian Partridge, Pheasant, Fox Squirrel, Gray Squirrel, Deer, Ruffed Grouse, Cottontail Rabbit, Raccoon, the Ohio breeding species of waterfowl and indirectly nearly all Ohio land vertebrates. A co-operative waterfowl banding project has been inaugurated at Pymatuning Reservoir in connection with more extensive studies of breeding waterfowl. More than 400 ducks have been banded to date.

Eight men are engaged in full-time research, assisted by a number of undergraduate students. The preliminary work on Gray Squirrel, Ruffed Grouse and Deer is completed, and one phase of disease investigation, "Parasites of the Gray and Fox Squirrel," is nearing completion. The development of techniques for measuring animal populations and methods of conservation management are also subjects of research and investigation.

In the development of an extension education program, assistance and advice have been given to 4-H club leaders and to many farmer-landowners whose inquiries have been sent to the Research Station. Papers on completed phases of conservation research have been distributed on request, in addition to many technical and educational papers. More than 75 lectures and radio talks have been given by the Station research men on various phases of wildlife conservation during the past year. A "Manual of Ohio Wildlife Resources," which will give qualitative and quantitative information on all wildlife groups in Ohio, is in process of preparation. A library relating to wildlife conservation is rapidly growing and is available to the people of the State.

For demonstration purposes, wildlife management units of township size have been set up in northwestern Ohio where effectiveness of "production" and "harvest" techniques are being tested and farmer-sportsmen relationships studied. The 52,000 acres of state owned forest lands in the unglaciated hills of southern Ohio have been used for research and demonstration of management methods

Eight Wildlife Research Stations similar to the one in Ohio are located on a regional basis throughout the United States, bringing into close co-operation the large State Universities, the State Conservation Departments and the U. S. Biological Survey. The work of these stations is based on facts, not opinions, and involves the most careful application of scientific data and ecological principles, in modifying the land use program for the conservation of our valuable wildlife resources.

Roosevelt-Shawnee Project—A three-year wildlife research project sponsored by the Ohio Academy of Science is nearing completion on the Roosevelt Game Preserve. The investigation has been jointly supported by the Ohio Division of Conservation and the Ohio Wildlife Research Unit at Ohio State University. The investigator, Mr. F. B. Chapman, has been especially interested in wildlife land-use and forestry-wildlife relationships and has attacked the problem from those angles. Basic data on which a sound management program may be based, has been obtained on Gray Squirrel, Ruffed Grouse and White-tailed Deer (all forest game species). Preliminary work on the Shawnee-Roosevelt project will be completed by the present worker in August, 1938.

The gray squirrel study indicated that the Roosevelt area supported a population of only 10 squirrels per 100 acres during an excellent squirrel year. Squirrel populations fluctuated from year to year. A five-year cycle was rather definitely demonstrated. Three mimeographed publications dealing with various phases of the study have

been issued, and a summary report will soon appear in the Transactions of the Third North American Wildlife Conference. A 120-page research report dealing with the gray squirrel has been completed.

A deer population of about 1,200 exists in Western Scioto and Eastern Adams counties. The annual increment there is about 200 fawns. Approximately 100 deer are killed annually. The principal causes of deer mortality are, in the order of their importance: (1) poaching, (2) dogs, (3) highway accidents, (4) other accidents. The food supply is sufficient for the number of deer now present. The Ohio deer range should be extended in the next decade due to the reforestation trend in southeastern Ohio. A paper on "Trends in Land-use as Related to the White-tailed Deer in Ohio" will be given at the Ohio Academy of Science meeting at Wooster in 1938. A research report on this species is being completed.

About 1,000 ruffed grouse occur on the 9,000 acre Roosevelt Preserve. A 50-page research report has been completed. A mimeographed report on the "Breeding Birds of Nile Township, Scioto County" has been published as Release No. 40, Ohio Wildlife Research Unit.

During the past three years 14 permanent sanctuaries and refuges were established on state lands in co-operation with the Ohio Division of Forestry and the Division of Conservation. Sanctuaries are of four types: (1) wilderness areas for research, (2) recreational areas, (3) wildlife management areas, and (4) forestry management areas. Ten sanctuaries (involving 4,000 acres) are located in Scioto County (on Roosevelt Preserve and Shawnee Forest), two in Pike County (600 acres), and two in Ross County (600 acres). All state lands outside the sanctuaries are designated as "State Hunting Preserves" Controlled squirrel and rabbit hunting was permitted in 1935, 1936, and 1937. About 3,000 hunters were accommodated during that period.

In a study of the effects of timber management on wildlife, it was found that about 56,000 potential den trees were removed from the Shawnee Forest during stand-improvement work. However, the felled trees made the area more attractive for grouse, which utilized them for drumming logs. In general, timber management resulted in a greater production of wildlife foods. The relations of forest fires and severe floods to wildlife were also studied. Separate research reports on surveys of food, cover and water resources in the region have been completed.

The management program involved the preparation of 2,000 feet of clearings (100 feet wide) in forest areas, the construction of 15 log and rock dams, erection of deer crossing signs, provision of salt and winter feed for deer, cultivation and planting of annual food patches, cleaning and enlarging 16 deer licks and water-holes, permanent plantings of 60,000 game food and cover plants of 70 species in the Odell Sanctuary, and the establishment of a small nursery on the Roosevelt Preserve. The production of nursery stock in large quantities was impossible due to lack of watering facilities. However, 2,880 plants will be available for distribution to the seven wildlife management districts of the state in April, 1938.

Ohio Fish Management Program—The Ohio fisheries management program involves the arbitrary division of the State into eleven fish management districts, each consisting of a single large stream system, or a series of small similar stream systems, or a group of comparable lakes or ponds. A biologist is stationed in each district with headquarters at a university or college where he has access to laboratory and library facilities and can stimulate research upon important problems by the faculty and student biologists. It is the job of each of these men, called fish management agents, to become thoroughly familiar with the fish producing waters and their fish populations in his territory. Fish populations cannot be studied in their entirety, and the method of collecting representative samples is used. From the fish collected much information is obtained. Scales are taken and sent to headquarters where they are studied and measured, and the rate of growth is determined. Waters are considered to be carrying below their capacities when the fish have grown abnormally fast and such waters are supplied with more fish from the inland State fish farms. Fishes are supported by very complex food chains which may be varied and different for each species, and all details of these chains have not yet been discovered or formulated. Some studies of fish food production have shown little correlation with actual fish production, and studies of the growth rate and abundance of fishes in such waters have appeared to be the only criterion for judging their fish producing and carrying capacities.

There is a State fish hatchery at Put-in Bay where the eggs of commercial lake fishes are incubated and hatched, and the young fish are liberated in Lake Erie promptly after hatching. The south shore bays and island region of Lake Erie also provide good sport fishing and the excess fishes of the gamey species are transplanted to inland waters to improve fishing there. There are also about 3,000 acres of waters impounded for city waterworks which serve as rearing ponds because public fishing is not permitted in them and the fishes are transplanted to waters which may be fished. There are smaller establishments known as State fish farms located at St Marys, Indian Lake, Buckeye Lake, Portage Lakes, Defiance, Bucyrus, Chagrin Falls, London, Xenia, Newtown, Piqua, and Kincaid Springs. At these places most of the practices of farm management are used, including pond bottom soil management, plant crop production (and weed control), intermediate animal crop production (small crustaceans), and lastly, fish production. Fish production is practised as a specialized phase of animal husbandry, including the development and maintenance of brood stocks of bass, bluegills, bullheads, forage minnows and crayfish. This involves the improvement of stocks by selective breeding, and the rearing of the young, with full attention to food, sanitation, and behavior requirements.

Since many land owners object to trespass by anglers, part of the Ohio fish management program involves the acquisition of control of stream margins by the State Division of Conservation. A number of land agents are employed to contact land owners and secure fishing

easements. Efforts are concentrated upon the streams recommended by the local sportsmen's organization, but will be extended presently to include all fishable streams in the State. These easements protect the land owner against property damage, as the State builds parking places for anglers' cars, builds stiles over fences, and exercises control over the fishing in the streams. Streams controlled by easements will be improved by erosion checks, small dams, deflectors, etc., and five crews of men will soon be operating throughout the State doing stream improvement work.

Research upon problems fundamental to the program is being conducted as a co-operative project with the Franz Theodore Stone Biological Laboratory of the Ohio State University. Some of the problems being investigated are the effects of small dams in streams upon fish food production and upon the fish populations present, migrations of stream fishes, viability of winter eggs of water fleas, prevalence and control of fluke infections of fish, effects of flood waters on stream fishes, distribution of mussels in Ohio streams, effects of turbid waters on aquatic plants, cycles of fluctuations of abundance of game fish species, and methods of producing bait minnows and crayfish.

Recommendations—Your Committee recommends:

(1) That the Ohio Academy of Science go on record favoring an annual appropriation from the general revenue funds sufficient to permit the Ohio Forestry Department to purchase submarginal lands for forestry and recreational purposes and for personnel sufficient properly to care for such lands.

(2) That suitable legislation be enacted to permit the state to take over such tax delinquent land as may be desirable for purposes of recreation or conservation when unpaid taxes shall have accumulated for three years, the title to such lands to be held by the Forestry Department, the Division of Conservation or the Ohio State Archaeological and Historical Society.

(3) That a joint meeting of the forestry and wildlife interests of the state be held, for the purpose of securing further co-operation between and co-ordination of the two fields of endeavor toward the end of better conservation of our natural resources.

(4) That suitable legislation be enacted toward outlawing pole-traps. It is the firm conviction of your committee that the pole-trap, except in a few cases, is objectionable because it destroys more beneficial birds than destructive ones.

(5) That further areas at Fort Hill, the Oak Openings west of Toledo and at Mohican State Park be acquired for conservation and recreational purposes. Your committee also especially recommends for this purpose the acquisition of land in the vicinity of Beaver Creek in Columbiana County, Rock Run in Jackson County, and marsh areas along Lake Erie.

(6) That suitable literature be provided relating to our State recreational areas for distribution to visitors to such areas.

(7) You committee commends the important research on wildlife problems which has been accomplished in the Scioto and Pike County State properties, and urgently recommends that such research be continued.

(8) Your committee reiterates its firm opposition to pest hunts and "vermin" killing campaigns and to indiscriminate poisoning campaigns directed against our native mammals or birds.

Respectfully submitted,

G. W. CONREY,
E. L. WICKLIFF,
ARTHUR T. EVANS,
EMERY R. HAYHURST,
EDMUND SECREST,
LAWRENCE E. HICKS,
F. H. KRECKER,
WILBER E. STOUT,
EDWARD S. THOMAS, *Chairman*.

Bird Books

These two volumes contain the series of articles on North American birds that have appeared from time to time in the last several years in the *National Geographic Magazine*. The 37 articles in the two volumes treat not only all the orders of birds in North America north of Mexico, but also various special subjects such as migration, bird banding, song-recording, and many others. These volumes are profusely illustrated, containing 204 pages of color plates which illustrate about 950 varieties of birds, 228 photographs, 17 migration maps, and 5 pen and ink drawings illustrating structural characters of birds. The color plates, except for a few of warblers drawn by Fuertes, are by Major Allan Brooks. Opposite each color plate are brief accounts of the species illustrated, including their characteristics, range, breeding habits, and interesting features of their behavior.

This work throughout is written in a popular and readable style, with which readers of the *National Geographic Magazine* are familiar. Technical details are reduced to a minimum. The color plates, for the most part, are excellent. The two books are well bound, and printed on a good grade of paper. The table of contents in each volume is listed alphabetically according to the first word of each article heading, which appears somewhat inconvenient, but each volume is fully indexed.

"The Book of Birds" should prove of considerable interest to both biologists and laymen. The student of birds will find much of value in the treatment of the various species and groups, and in some of the articles on special subjects. The article on bird migration, by Frederick C. Lincoln, is particularly good; this article is an abridged version of Lincoln's "The Migration of North American Birds" (U. S. D. A. Circular No. 363), but it has lost nothing in being abridged. Anyone interested in nature will find in these volumes a wealth of accurate and interesting information and illustrative material. Here is a set of books which seems well worth the small price of five dollars.—*Donald J. Borror.*

The Book of Birds, edited by Gilbert Grosvenor and Alexander Wetmore. Vol. 1, viii+356 pp.; Vol. 2, 123 pp. Washington, The National Geographic Society, 1937. $5.00 per set, obtainable only from the Society's headquarters, Washington, D. C.

PRESIDENTIAL ADDRESS

"WHEN ARE WE SCIENTIFIC?"

C. G. SHATZER,
Wittenberg College

No one will question the statement that frequently there arises in the mind of the undergraduate and graduate student the inquiry: Where and how does this particular day's work fit into the pattern of thought and learning? Related to this inquiry is a second one: What are the tests to which this work must be subjected in order to judge the quality of its truth and worth? The fact that these questions arise in students' minds has not been given adequate attention by teachers to whom the training of youth has been entrusted.

If professional people will keep these ideas in mind their own methods of. thought will be improved and they will frequently correlate the specific task with the larger problem, thus maintaining perspective for those with whom they work.

The mental concentration necessary to the successful completion of an immediate problem frequently excludes a grasp of that whole of which the day's work is a part. Thus perspective in thought, freedom of spirit, and incentive to enthusiastic action are lost. The exploration of a single, minute island of thought is likely to delay, if not prevent the discovery of the archipelago of knowledge. Circumstances and habit tend to confine our thinking within rather limited areas. It may prove interesting and profitable to detach our minds from the specific problems in which we have been interested today and review some of the broad premises upon which research depends. As a revered graduate school instructor was accustomed to say: "The review of an old problem along distinctive avenues of approach is constructive and creative thinking." I have no hesitancy, therefore, in directing your thought to an old, yet ever-new problem—"When are we scientific?"

The primary function of this paper is to raise the questions: Is a scientific method in one field of thought necessarily a scientific method in another? Are the criteria of scientific quality in one field of learning the criteria of truth and reality in all fields of learning? My tentative answer to each of these questions is "No." Are there specific tests of reality that are intrinsically a part of one field of thought that are not tests in another field? My answer is "Yes." Furthermore, these tests are the critical tests of scientific quality in the specific field. The intent is to direct attention to the fact that scholars researching in any field become convinced that their thinking and experimenting are scientifically done. This attitude of mind possesses distinct merit. Unfortunately they unconsciously draft the corollary that they have devised the only scientific method. This is an unscientific deduction. As a mother looking fondly at a passing regiment said: "They are all out of step but our son Jim."

The undiscriminating use of the terms science and scientific has contributed a great deal of confusion to our thinking. The evolution of the physical, the biological, and the geological sciences has so dominated thinking that whenever the word "science" is used there is a connotation that the reference is to one of the above sciences. A concomitant error is involved in the use of the word "scientific." Unintentionally the methods of investigation and the criteria of validity employed by the physical, biological, and geological investigators have been accepted as inseparably associated with, if not the embodiment of, scientific thinking. This persistent association of the word scientific with those sciences in unjustifiable. "He is a scientific thinker" is a typical use of the word and connotes something infinitely more than compliance with the techniques of the physical sciences. As thus used the true meaning is that the worker subjects his information to those tests of validity that are of the essence of the information with which he is working, and that he subjects his methods to the tests of rectitude intrinsically associated with a specific field of thought. These tests are not necessarily the measures of scientific quality employed in physics, chemistry, biology, or geology. A deliberate effort should be made to divorce the word "scientific" from the implied relation to the sciences: physics, chemistry, biology, and geology, except when designating the quality of the work done in these subjects. There are accurate and valid tests of the quality of the information and of the methods of thinking in history, geography, theology, and philosophy, that are as scientific for these fields of thought as are the accepted tests for physics for that subject. That some of the tests are valid in several fields is a reasonable assumption, but it is just as reasonable to assume that there are inherent tests for a specific field which are not common to any other field.

The above use of the phrase "fields of thought" is an attempt to limit the discussion of the question "When are we scientific" to categories and thereby simplify the problem. There is an infinite number of subjects of thought, but since the universities and the colleges have organized their curricula upon a group or division plan, it is reasonable to assume that there are inherent likenesses and similarities running through the subject matter and methods of thinking employed in a group. If such is the case a list of the tests of scientific quality derived for a subject such as physics, will be typical of, and applicable to, that field of thought commonly designated as the Physical Sciences. Furthermore, defining the tests of validity of information and the methods of thinking in a subject such as geography, in the social science group, ought to establish the criteria of scientific thinking in the social science field and thereby define the major criteria of scientific thinking in history, biography, economics, geography, political science, sociology, and psychology if it is classed as a social and not a physical science. Thus the limits of the problem are narrowed and a survey of the question "When are we scientific" may be confined to two of the five or seven groups generally outlined in college catalogs.

The primary premise is: Each field of thought possesses criteria of truth inherent in, and organically a part of it, which are the essential

measures of its scientific quality, but not necessarily tests of validity in other groups. If this premise is tenable, then a catalog of the criteria in each field should be made. Any scholar must accept the tests of validity recognized in fields other than his own if he wishes to justify his claim to scholarship in his own field. Furthermore, no one field of thought can impose its tests upon another field and insist that they be considered valid tests of truth thereto, unless they give evidence of belonging organically to the field.

I choose to undertake the study of the following two groups chosen from the college catalogs, in an effort to list some of the criteria of scientific quality of each:

1. Physical Sciences: chemistry, mathematics, physics.
2. Social Sciences: including biography, economics, geography, history, political science, psychology, sociology.

The principles of logic are universal prerequisites of scientific thinking. The syllogism, types of terms, definition, and classification, valid moods and other statistical forms, hypothetical and disjunctive arguments, analogy, and similar principles of reasoning are universal tests of scientific quality. They are not the specific tests by which scientific thinking in one field may be differentiated from scientific thinking in another field. The present quest is for those specific tests of scientific quality that characterize the physical sciences, but are different from the tests for the social sciences and all other fields of thought. The following two discussions attempt to segregate and catalog the tests for the physical and for the social sciences. It would be folly to claim that this treatment is exhaustive. The primary intent is to state a problem in an objective way.

Two lines of investigation have been pursued during the past two years in the search for definite statements of criteria of scientific quality of thinking in these two fields.

First: The dissertations presented for the advanced degree of Ph.D. in various institutions have been examined in search of some principles which were employed in testing the scientific quality of the research. It was discovered that the dissertations in any department are confined to a narrow field, and the dissertations directed by any one man are restricted to a more limited field. That should be the situation. A further examination reveals the fact that the method employed in the original dissertation, probably the director's own dissertation, is practically duplicated in the successive theses. Similar materials and identical or analogous circumstances have been introduced, but in reality there are no fundamental differences between problems. One of the striking illustrations is in taxonomic problems in biology. All that is to be found in these theses is an amplification of a problem previously explored. Such a discovery leads to the conclusion that well-defined tests of scientific quality have not been consciously employed, but that a pattern was constructed in the original dissertation and the scientific quality of successive dissertations has been judged upon the basis of how well they conformed to that pattern. All such research is commendable and certainly makes valuable contributions to knowledge.

The disturbing deduction must be that the "ruling theory" or "authoritarian method" of thinking has been the dominating test of scientific quality employed. Strange to relate, this method has been severely criticised by experts in the physical and biological fields when employed by investigators in other fields.

This line of investigation did not yield specific statements of criteria of scientific quality.

A second line of investigation was followed. A search was made in the books and journals that discuss methods of research, investigation, and thesis writing to locate, if possible, the criteria by which the scientific quality is judged. Brief references are made to the problem in the books and journals, but no inclusive catalog was found. The books of logic define clearly the principles of logical thought. However, it is not logic's function to define the basic criteria of truth and reality, or the scientific quality of thinking peculiar to a specific field of thought such as physics or philosophy.

With these two lines of investigation as a background the writer attempts to develop a brief list of the criteria of scientific quality for each of two fields: the physical sciences and the social sciences.

Quest number 1—The Physical Sciences:

Each of the so-called fields of thought is concerned in its own way with the interpretation of the world. Departmentalizing subject matter and collecting the departments in fields of learning is artificial and is a response to the limitations of the human mind which demands that knowledge shall be classified and cataloged. Classifying knowledge always suggests a simplicity that does not exist. Man thinks in types which represent ideal conditions. He infers that principles applicable to the type or type conditions are tests of reality for the group even into the twilight zone where the group amalgamates with other groups, or conditions merge with adjacent conditions.

Physics and chemistry deal with materials in terms of constants. Non-variability is a fundamental consideration to the physical scientist. He has constructed his method of investigation upon the advantage that non-variability gives him. In the words of Ritchie, "He assumes, for instance, that in considering a small portion of the universe he can neglect all the rest."[1] When he has finished with that small bit "He looks around and brings another small bit of the universe into his ken, and continues altering his field of observation until his isolated system behaves as though it were really isolated. All the time he is able to leave the whole universe as such, alone; he gets all the advantages he could have got out of a theory of the universe without the disadvantages."[1] Ordinarily he does not attempt a summation and to a much less degree an integration of the units.

Pure science deals with these isolated units. Probably the only distinction between pure and applied science is that applied science is concerned with the relation between the isolated units of pure science. Out of these inquiries of pure science emerge those criteria that are the bases for judging the scientific quality of the work.

[1]Ritchie, A. D, Scientific Method, p. 7.

Whether a piece of work is scientific or not in the physical sciences may be measured by the following tests:

1. Has the human factor been eliminated or reduced to a constant in performing the experiment and in recording results and observations?
2. Has the material or the action been resolved into a single isolated unit? Have the variables been reduced to one?
3. Has simplicity been attained?
4. Have the results been attained by both a direct and indirect attack, i. e., can the results be secured by a process of elimination, or as a residium of the solution of associated problems?
5. Can the results be expressed in a mathematical formula of quantitative, not descriptive terms? Sumner has said, "Science is science—only insofar as it is capable of mathematical expression."[2] In the physical sciences, each function in the formula must be capable of calibration. There are some fields of thought in which the facts that determine reality are not amenable to calibration.
6. Any description of characteristics and interpretation based upon observation in natural settings must be checked repeatedly and confirmed in a man-devised experiment.
7. Identical results must be secured by independent investigators using the identical methods and materials of the original investigator.

There are three well-known methods of investigation:

1. The Ruling Theory—Authoritarian.
2. The Working Hypothesis.
5. The Multiple Working Hypotheses.[3]

The human mind possesses an irrepressible tendency to resist the invalidation of any explanation of a phenomenon that it has proposed. The fact that this tendency exists demands that some method of investigation shall be devised that will automatically annul it. Many people cannot say, "I do not know." They employ the "ruling theory" or "authoritarian method" in their thinking. This attitude of mind is a hangover from the day when a scholar could compass the whole of human knowledge, when most of the information and training were in possession of a limited few. The scholar then made plausible explanations of phenomena that were readily accepted as true. Thus developed the "ruling theory" or "authoritarian" process of working. As Emerson said, "We hate to think"—and hope that some one will save us that discomfiture by producing a formula for action. The investigator should be conscious of this tendency and devise methods to render impossible its practice.

The single hypothesis procedure possesses the same weakness of permitting men to give undeserved protection to a brain-child.

---

[2]Sumner, Frances B., Scientific Monthly, Vol. XXV, No. 4, October, 1937, p. 345.

[3]Journal of Geology, October, November, 1897, Chamberlin, T. C. Vol 5, No. 8.

The question naturally arises, Is there any method available which mechanically eliminates this tendency toward the expression of prejudice?" If such a device is available it ought to be discovered most readily in the physical sciences since they deal with the inanimate.

The "multiple working hypotheses method" utilizes the process of elimination to a high degree, consequently its use might be considered a criterion of scientific quality in investigation. Any one will acknowledge that building cognate hypotheses is difficult. Nevertheless there is merit in the severity of the task. As the investigator builds the several hypotheses he unavoidably discovers new ideas, observes new conditions and relations that he may not suspect exist when the authoritarian or single hypothesis method has been employed.

Quest number 2—The Social Sciences:

Man and man's activities are the central ideas in the social sciences. These premises must be accepted when a question is raised concerning the scientific quality of the work done by investigators working in the field. The central idea is the interpretation of the responses of life forms to the social and physical environment. In his research work the historian, the economist, the biographer, the political scientist, is confronted with more than the immediate environment—he must deal with the biological heritage, the social heritage, the philosophy and experience of the individual as well as of the group of which he is a part.

The period when the major function of the historian, the political scientist, the economist, and the geographer, was fact finding and the recording of information is past. That was a very important period in social science history. The present is a period when interpretation is the major objective of research. This fact is of supreme importance and demands major consideration in any attempt to set up standards of scientific quality for the work done in the social sciences.

The ever-changing, dynamic world doctrine is generally accepted. This fact demands that some new criteria of truth, inherent in, and organically a part of the social sciences, must supplement the previously-accepted tests of the scientific quality of research. Furthermore, it is absurd to superimpose upon the man-centered social sciences the tests of validity of mathematics and physics which are primarily concerned with the inanimate. Those tests possess a limited application, but are not inclusive of all tests nor are they the fundamental ones.

May it be true that students of social sciences, education, philosophy, and religion permitted themselves to be hurried into changes of procedure by the success of investigators in the fields of physical science, biological science, and thereby became imitators when they should have examined their own premises and developed methods consistent with the inherent characteristics of their own fields.

Educational statistics exhibit, in a striking degree, the agonizing efforts a field of learning experiences when it attempts to ape the successful technique of another field of learning and to use methods that are not inherently applicable to itself. The formulae used in statistical methods in education are not formulae. Their symbols are not the

language of constants, but of variables that are wholly descriptive—not definitive. It is quite proper to use these formulae if it is recognized that the symbols represent descriptive terms. It must be recognized that they are not mathematical formulae—they just simulate formulae, hoping thereby to gain greater respectability in an age when an unjustifiable attempt has been made to subject all scientific quality to quantitative measures.

Man is a complex organism, the animate and inanimate environment in which he moves is complex, the parts inseparably interwoven and integrated—consequently it is impossible to set parts of the environment or responses off as units by themselves and deal with them as separate units as is done in the physical sciences. The very nature of the social sciences precludes the possibility of considering a small portion of the universe by itself and neglecting all the other parts. Consequently, we may be compelled to accept the training and character of the man who makes the interpretation as the best criteria of validity of thought. If such is the case, we must test the quality of his research by testing the researcher for his capacity to discover significant information and test the quality of that information; for his alertness to existing conditions, and logical, effective summarizing. Thus we arrive at the idea that there are at least two measuring scales by which we test the scientific quality of investigation in the social sciences:

First: We judge the quality of the research by evaluating the training of the writer. Is he trained in the mechanics of scholarship, i. e., trained in paleography, in lexicography, in rhetorical expression; is he able to analyze his premises and judge whether there is unity and continuity in his own thought and writing, as well as able to compare and contrast his work with that of scholars in the identical and similar fields?

Second: We judge the quality of the research by evaluating the personal qualities of the worker—his philosophy of life, attitude of mind, i. e., his sympathies, enthusiasms, personal interests, prejudice, envy, malice, his experience in the world of reality, and his ability to live successfully with men. This group of tests in reality is a test of the character of the worker.

The experience of the worker in the social sciences is a major test of the scientific quality of his work. There are two types of experience: actual and vicarious. To a degree it is possible for a geographer to be so thoroughly informed concerning the habitations, the tools, the religion, the social customs of a human group living a life of isolation in a dissected upland that he becomes a part of a Scottish clan that he may live, to a degree, the life of Scott's Roderick in the "Lady of the Lake," or, he may visualize the life of the mountaineer of our Appalachians until he can approximate the feud, blood-retribution spirit of the Hatfields and McCoys. However, his vicarious living can only approximate reality and the approximation of the reader of his description will be of lesser degree. The fact is that the vicarious experience of the reader of the geographer's interpretation can never equal actual experience. There is no subjectivity that can possibly replace objective experience.

It is difficult for us to accept these tests as criteria of scientific quality of the geographer's and economist's work simply because we have become so greatly enamored of the quantitative methods of the physical sciences and are suspicious of qualitative tests. Nevertheless, they are the specific tests of scientific quality in the social sciences simply because they are of the very essence of them.

The tests of scientific quality in the social sciences are at the extreme opposite pole from the tests of scientific quality in the physical sciences. They express a contrast that naturally exists.

In summary: Students classify their knowledge in compartments that have been designated fields of thought. In all classifications it is the ideal, representative subject matter and ideal method of thinking that are considered when the particular field is named. Little if any thought is given to the zone where one field passes indistinguishably into another field. There is subject matter and there are methods of treating information that are common to all the fields of learning. There are tests of scientific quality that are common to several, but not to all fields. The significant fact is that there are a few tests that are the specific tests of validity in a particular field and these are the tests that should be given the greatest weight in evaluating the scientific quality of the studies in that field. Helmholtz acknowledged the existence of this idea when he pleaded for an increased and closer connection of the points of view of the various sciences especially when these dealt with the same subject or similar subjects.[4]

If these specific differences can be clearly defined, scholars will have at their command the tools by which to judge scientific quality. Definitions can be made and when they are made scholars in any field will have at their command criteria by which to judge the work in that field. Possibly the day may come when the physical scientist will not accuse a worker in the field of philosophy and religion of being unscientific because he has not employed the tests of physics and chemistry in his work. When these definitions are made then students are going to acquire a finer appreciation of one another's work; are going to be more sympathetic with one another's endeavors; and are going to be more scientific in their appreciation of the whole rather than parts of knowledge.

This brief review of a problem is presented with the hope that other analyses may be offered and that both graduate and undergraduate students may be aided in their quests for statements of tests of scientific quality of investigation.

---

[4]Jones, W. Tudor, Contemporary Thought of Germany, p. 129.

HEREDITY AND EDUCATION[1]

PAUL POPENOE

Every human being begins life as a microscopic speck of jelly—the fertilized egg cell. From this in the course of nine months, with the addition of nothing from the outside except food and water, he develops into the baby we see at birth.

Obviously, the traits he shows at birth are not the product of education in any ordinary sense of the term. They are the product of the development of inborn potentialities that are largely independent of educators.

The same is true of many other traits that appear not at birth but some time later. The teeth will appear in due time, the beard in due time, the bald spot in due time—no one imagines that the appearance of these has been brought about or largely influenced by education.

Should we not begin to recognize that the same is true of many other traits, intellectual and emotional as well as physical? Recent breeding experiments with lower animals, showing clearly that such traits as temperament and emotional sensitivity are inherited, should lead us to be more realistic in our treatment of students either in higher or lower schools.

To a greater degree than we have sometimes admitted, a large part of the child's development represents not the skill of his teachers, but the unfolding of his inherent potentialities. These appear at definite rates of maturation, and nothing can be done to hurry them. The parent who tries to teach a child to walk simply interferes with his ability to walk. The child does not learn to walk—he grows to walk and will do so best if left alone and given a chance.

Just as every trait has its own rate of maturation, so every child has his own rate. Every child is unique, and "standard tables" of heights, weights, ages of walking, talking, teething and the like, have little meaning or value for use with individuals.

If we are to take account of these inherited differences in dealing with children, we should pay more attention to the greatest inherited difference that can exist between two chil-

[1]Abstract of invitational address before the Forty-eighth Annual Meeting of the Ohio Academy of Science, at the College of Wooster, May 6, 1938.

dren—that which makes one male and the other female, respectively.

Not only do the two sexes differ, literally, in every cell of their bodies, but they differ in many ways, biologically, that are of profound importance in education. They differ in their viability (more boys dying at every age); they differ in their basal metabolism—girls averaging 10% lower than boys, a fact that may be associated with the greater aggressiveness of the male. They differ in structure, in function, in glandular make-up and balance, in emotional equipment. They mature at different rates, girls being a year or more ahead of boys by the time they reach high school.

This difference in rate of maturation causes many difficulties. Because we start boys and girls off together in the first grade at the age of six, and move them along together from year to year, we are always forcing boys to compete with girls who are superior to them—more mature socially and emotionally. Such a handicap is bad for both sexes.

Development of the reproductive system offers one of the difficult problems that educators have failed to take into account. The long period of years during which the reproductive system is developing makes it much more susceptible to damage from outside conditions than is the digestive system, the nervous system, or some other part of the body that has a short, direct process of development concluded largely in a few months, even before birth, as compared with a quarter of a century during which the reproductive system is developing in women. There are two serious consequences that educators should take into account:

1. At adolescence, the girl's reproductive system has to undergo profound transformations to change in a few years from that of a child to that of a woman. This process—much more profound than in boys—makes a heavy demand on the girl's store of vitality. If she has not enough vitality—if she is using up her vital capital by too great physical activity as in competitive athletics, too great intellectual activity as in working for a scholarship, too great emotional activity as in an immoderate social life—the transformation of the reproductive system can not take place. She remains a child in that respect, though she becomes a woman in other respects. This failure of development of the reproductive system, due to carrying too heavy a load of activity during adolescence, is

apparently the most important single cause in the permanent sterility of so many educated women. In a study of sterility among such women, it was found that one-third of them suffered from this form of physical infantilism.

2. This profound change in the reproductive system, on the other hand, seems to influence the girl's intellectual development unfavorably. In a study at Stanford University, of very bright girls in the California public schools, it was found that they showed a decline in average intelligence, amounting to 13 points on the scale of intelligence quotients, during adolescence, while their brothers showed little or no such change. When a girl is born with the highest possibilities of intellectual achievement, it appears that she must sacrifice some of that possibility during her adolescence in order to prepare herself biologically for motherhood.

This problem of dealing with intelligent girls at adolescence, in such a way as to promote both motherhood and intellectual development, is one which educators have almost wholly ignored. Sometimes the results of this ignorance have been disastrous.

Constitutional differences within each sex also deserve more attention. Two extremes can be recognized readily enough, with most of us somewhere in the middle. At one extreme is a slender type of body-build associated with the introvert personality—a mind which tends to turn inward, to be concerned with its own thought processes. At the other extreme is the thick-set type of body-build associated with the extravert whose attention is turned outward—who is concerned with other people rather than himself, with what is going on around him rather than what is going on inside his own skull.

A gathering of scientists, inventors, or poets is likely to consist mainly of introverts. It will look different and behave differently from a gathering of extraverts such as one would find at a convention of Elks or Shriners or in a caucus of politicians.

These contrasted types often appear in the same family, because of the mixture of traits in the ancestry. They need to be handled differently. The introvert child must be continually pushed out and made to associate with people, so that he will not become a timid recluse. The extravert child needs to be encouraged to concentrate, so that he will not become a superficial show-off.

Their vocational futures will normally be different. The introvert will excel in a job requiring persistence and attention to detail. He will work well alone. The extravert will do best when associating with other people.

Because the child's traits are the outcome of his ancestry, and because his parents know his family background better than anyone else does, his parents should be the best educators. Under city conditions, it is inevitable that the job of educating children be turned over largely to school teachers; but it is easy to carry this too far. Parents are still mainly responsible for the child's education in matters pertaining to health, character, and religion. With better training for parenthood, such as the schools are now beginning to give, parents should be able to do a much better job, particularly in the development of such parts of the child's heredity as form the basis of good character and personality, and the suppression or circumventing of such of his potentialities as are socially undesirable. Beyond this, a closer tie-up between home and school is obviously needed, if the teachers are to understand the material they have to work with.

Geology Simplified

The author has admirably achieved his objective, stated in his subtitle, by treating the earth as a fascinating story stripped of strange and confusing language. Professor Shand is a British geologist who recently came to this country to take a professorship at Columbia University. Prior to this he lived for several years in South Africa. His book is a somewhat modified form of the 1933 edition published in England.

Although the work touches upon the geologic development of the surface features of the earth, its greater concern is with the hidden aspects of the earth's crust and interior, along with the dynamical problems involved. Such chapter headings as "The Book of the Rocks," "What Lies Beneath the Crust," "Deeper and Deeper," "The Problem of Mountains," "How the Crust Is Held Up," and others, express the tenor of the story. Where mathematical equations are needed the author has resorted to ingenious simplicity which fascinates the reader. Considering the history of the author and the book one understands the emphasis placed upon European and African examples and illustrations. By the same token the trend of European geologic thought is explained. It is indeed unfortunate, however, that the author should be so "sold" on the spectacular hypothesis of drifting continents as to conceal from his readers the opposing and more generally accepted views. Nevertheless, this book should succeed in arousing additional interest in the fundamental and broad problems of earth science.—*Paris B. Stockdale.*

Earth-Lore: Geology without Jargon, by S. J. Shand. viii+144 pp. New York, E. P. Dutton & Co., 1938. $1.25.

ADDITIONS TO THE REVISED CATALOG OF OHIO VASCULAR PLANTS, VI.*

JOHN H. SCHAFFNER

Our knowledge of the flora of Ohio continues to be augmented because of the enthusiastic work of many amateur collectors in various parts of the state. During the past year, through the aid of four student NYA workers, more than 2,000 specimens have been mounted and added to the Ohio State Herbarium, and a considerable number of specimens have also been added to the general herbarium collection. Among the Ohio specimens are sixteen species of vascular plants new to the state list. Numerous other records extend the known distribution range in the state. Thus, much material is being accumulated which will be of great value in the future study of the vegetation of Ohio. The card index with Ohio records indicated by counties on the card maps is nearing completion and will be of great assistance in facilitating distribution studies of the species.

10.1. *Lygodium palmatum* (Bern.) Sw. Climbing-fern. In thicket at edge of old abandoned quarry. Good Hope Twp., Sect. 26, Hocking Co. Mary N. Thomas, John S. Thomas, and Edward S. Thomas.

12. *Polypodium polypodioides* (L.) Hitch. Gray Polypody. Ohio Twp., Gallia Co. Floyd B. Chapman and Conrad Roth.

28a. *Asplenium cryptolepis ohionis* Fern. Ohio Wall-rue Spleenwort. Buzzard Rock, Adams Co. Leslie L. Pontius and Floyd Bartley.

55. *Equisetum kansanum* Schaffn. Kansas Scouring-rush. Hallsville, Colerain Twp., Ross Co. Leslie L. Pontius and Floyd Bartley.

59. *Equisetum fluviatile* L. Water Horsetail. Goodman's Bog, Green Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

64. *Lycopodium inundatum* L. Bog Club-moss. In swale in old quarry abandoned thirty years ago. Good Hope Twp., Sect. 26, Hocking Co. W. H. Walker and Edward S. Thomas.

70.1. *Picea rubra* Link. Red Spruce. On top of shale ridge. Probably escaped or accidental. Cascade Hollow, Big Creek, Concord Twp., Lake Co. C. A. Dambach and J. W. Sites.

81.1a. *Echinodorus cordifolius lanceolatus* (Engelm.) Mack. & Bush. Liberty Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

82.1. *Sagittaria longirostra* (Micheli) J. G. Sm. Long-beaked Arrow-head. Buckeye Creek, White's Gulch, Rock Run, Bowles Hollow, and Opher Hollow in Liberty Twp., Jackson Co. and in Green Twp., Ross Co. Leslie L. Pontius and Floyd Bartley.

89. *Triglochin palustris* L. Marsh Arrow-grass. Green Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

101.1. *Potamogeton crispus* L. Curly Pondweed. State Fish Farm No. 10. Portage Lakes, Summit Co. Fred H. Glenny. Lake O'Springs, Jackson Twp., Stark Co. Don M. Brown.

---

*Papers from the Department of Botany, The Ohio State University, No. 402.

119. Change name to *Anacharis canadensis* (Mx.) Planch. Common Water-weed. Cuyahoga, Summit, Erie, Allen, Licking, Pickaway.

119.1. *Anacharis planchonii* (Casp.) Rydb. Narrow-leaf Water-weed. Ashtabula, Geauga, Stark, Lorain, Erie, Williams, Logan.

119.2. *Anacharis occidentalis* (Pursh) Victorin. Lesser Water-weed. Wayne, Fairfield.

144.1. *Scirpus georgianus* Harper. Georgia Bulrush. Kirtland Twp., Lake Co. J. W. Aldrich.

150.2. *Scirpus pauciflorus* Lightf. Few-flowered Clubrush. Immell's Bog, three miles northwest of Kingston, Ross Co. Floyd Bartley and Leslie L. Pontius.

154. *Fimbristylis autumnalis* (L.) R. & S. Slender Fimbristylis. Pickaway Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.

174. *Cyperus inflexus* Muhl. Awned Cyperus. Pickaway Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.

180. *Cyperus diandrus* Torr. Low Cyperus. Joos Swamp, Hocking Twp., Fairfield Co. Chas. R. Goslin.

287. *Carex flexuosa* Muhl. Slender-stalked Sedge. Washington Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.

325. Change name to *Arundinaria gigantea* (Walt.) Chapm. and add "Spreading on a high ridge from plantings made before the Civil War." Brush Creek Twp., Scioto Co. Conrad Roth. Add also, "On the ridge above Revenge, Fairfield Co. Spreading apparently from an originally planted specimen." Lewis K. Cook. Note: *A. tecta* (Walt.) Muhl. is apparently only a form of *A. gigantea*.

385. *Arrhenatherum elatius* (L.) Beauv. Oat-grass. Near New Vienna, Clinton Co. Katie M. Roads.

390. *Deschampsia caespitosa* (L.) Beauv. Tufted Hair-grass. Immell's Bog, three miles northwest of Kingston, Green Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

395. *Sporobolus vaginaeflorus* Torr. Sheathed Rush-grass Between cement sidewalk and curbstone. Columbus, Franklin Co John H. Schaffner.

411. *Alopecurus pratensis* L. Meadow Foxtail. In water in a ditch, escaped. O. S. U Campus, Columbus, Franklin Co. R. A. Dobbins.

412.1. *Alopecurus carolinianus* Walt. Carolina Foxtail. (*A. ramosus* Poir.) Marion, Marion Co. C. J. Willard.

413. Change name to *Alopecurus aequalis* Sobol.

421.1. *Muhlenbergia cuspidata* (Torr.) Rydb. Plains Muhlenbergia. Buzzard Rock, Adams Co. Floyd Bartley and Leslie L. Pontius.

430. *Aristida purpurascens* Poir. Purplish Triple-awned-grass. Oak Openings, Lucas Co. Floyd Bartley and Leslie L. Pontius.

499. *Leptoloma cognatum* (Schult.) Chase. Fall Witch-grass. Green Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

500 *Syntherisma filiforme* (L.) Nash. Slender Crab-grass. Pickaway Twp., Pickaway Co. Floyd Bartley and Leslie L Pontius.

546. *Muscari comosum* (L.) Mill. Blue-tufted Grape-hyacinth Adams Co. Olga Zurcher. In herbarium of Capital University.

575. *Clintonia umbellulata* (Mx.) Torr. White Clintonia. Three miles S E. of Dundee, Tuscarawas Co. Don M. Brown.

629.1. *Iris pseudacorus* L. Yellow Iris. From Europe. Growing very abundantly around Meyers Lake, near Canton, Plain Twp., Stark Co Don M. Brown.

655. *Ibidium ovale* (Lindl.) House. Small-flowered Lady's-tresses On a hill west of Athens, Athens Co. W. P. Porter.

669. *Tipularia unifolia* (Muhl.) B. S. P. Crane-fly Orchis. Gallia Co. Leslie L. Pontius and Floyd Bartley.

781. *Lepidium perfoliatum* L. Perfoliate Peppergrass. A single plant. Barnesville, Belmont Co. Emma E. Laughlin.

808. Milton Hopkins has segregated our American plant from the Eurasian *Arabis hirsuta* (L.) Scop. as a new species, *Arabis pycnocarpa* Hopk. with the following characteristics: Style 0.5–0.9 mm. long; silique 3–5 cm. long, flat, one-nerved only to the middle of the silique or slightly beyond; seed winged all around narrowly, but very broadly so at the apex; cauline leaves close together on the stem.

814. *Arabis drummondi* Gr. Drummond's Rock-cress. Hopkins reports specimens collected by Moseley from Cedar Point, Erie Co., and Green Island, Ottawa Co.

815. *Arabis brachycarpa* (T. & G.) Britt. is invalidated by the homonym rule and our plant becomes *Arabis divaricarpa* A. Nelson, according to Milton Hopkins.

853. *Geranium pusillum* L. Small-flowered Crane's-bill. Hamilton, Butler Co. E. E. Good.

870. *Linum sulcatum* Ridd. Grooved Flax. Brush Twp., Scioto Co. Clyde H. Jones.

878. Change name to *Ailanthus altissima* (Mill.) Swingle.

883. *Polygala incarnata* L. Pink Milkwort Jackson Twp., Jackson Co. Leslie L Pontius and Floyd Bartley.

892. *Croton monanthogynus* Mx. Single-fruited Croton. Green Twp , Ross Co. Leslie L Pontius and Floyd Bartley.

950.1. *Triadenum longifolium* Small Long-leaf Marsh St. John's-wort. Bolster Hollow, near C. C. C. camp, Vinton Co. W. P. Porter and P. S. Wamsley.

985. *Viola pedatifida* Don. Larkspur Violet. Edge of a wood. Liberty Twp., Highland Co. Katie M Roads.

999. *Holosteum umbellatum* L. Jagged Chickweed. Union Cemetery, Columbus, Franklin Co. H. A. Runnels.

1037.1. *Claytonia caroliniana* Mx Carolina Spring-beauty. Boy Scout Camp, Madison Twp., Lake Co. H. B. and F. J. Tyler. Specimens also, heretofore placed with *C virginica* L , from Darke, Montgomery, Butler, Clermont, Lawrence, Jackson, and Franklin Cos.

1060.1. *Chenopodium incanum* (Wats.) Heller. Mealy Goosefoot. Pickaway Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.

1125. *Polygonum tenue* Mx. Slender Knotweed. Plain Twp., Wood Co. R. E. Shanks.

1131. *Geum flavum* (Port.) Bickn. Cream-colored Avens. Tar Hollow, Ross Co. Gordon S Crowl.

1149. *Rubus phoenicolasius* Max. Wineberry. In a hollow, Tiffin Twp., Adams Co. W. R. Vanlandingham

1207. *Amelanchier sanguinea* (Pursh) DC. Roundleaf Juneberry. Clifton, Greene Co. E. E. Good.

1233. *Gymnocladus dioica* (L.) Koch. Coffee-bean. Eden Twp., Seneca Co. Burton Fleet. MacDonald Twp., Hardin Co. Nora L. Jordan. New Albany, Franklin Co. Reported by Willis S Doran. Ohio Twp., Gallia Co. Conrad Roth and Floyd B. Chapman.

1271. *Coronilla varia* L. Coronilla. Franklin Co. Paul Zimpfer. In Herbarium of Capital University.

1275. *Meibomia illinoensis* (Gr.) Ktz. Illinois Tick-trefoil. Deer Creek Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley.

1283. *Meibomia obtusa* (Muhl) Vail. Ciliate Tick-trefoil. Kettle Hills, Lancaster, Fairfield Co. C. F. Walker and C. A. Dambach.

1284 *Meibomia sessilifolia* (Torr.) Ktz. Sesslie-leaf Tick-trefoil. Deer Creek Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley.

1313. *Lathyrus tuberosus* L. Tuber-bearing Pea. Defiance Co. C. J. Willard.

1316. *Clitoria mariana* L. Butterfly-pea. Blue Creek, Adams Co. Floyd Bartley and Leslie L. Pontius.

1337. *Heuchera villosa* Mx. Hairy Allum-root. Ohio Twp., Gallia Co. Floyd B. Chapman and Conrad Roth.

1343. *Ammannia coccinea* Rottb. Long-leaf Ammannia. Wood Co. Floyd Bartley and Leslie L. Pontius.

1349. *Rhexia virginica* L. Virginia Meadow-beauty. Jackson Twp., near McDonaldsville, Stark Co. Don M. Brown.

1351.1. *Elaeagnus multiflora* Thunb. Slender-stalked Oleaster. From China and Japan. Escaped in Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

1369. *Enonymus americanus* L. American Strawberry-bush. Vinton Co. C. H. Jones.

1371. *Pachystima canbyi* Gr. Mountain-lover. Scioto Co. Olga Zurcher. In Herbarium of Capital University.

1396. *Liquidamber styraciflua* L. Sweet-gum. Chenowith Creek Road, Pike Co. Gordon S. Crowl.

1418. *Castanea dentata* (Marsh.) Borkh. Chestnut. Apparently native in Montgomery Twp. and apparently escaped in Plain Twp., Wood Co. R. E. Shanks.

1439.2. *Betula populifolia* Ait. American White Birch. On low sand ridge. Apparently native. Harrison Twp., Henry Co. R. E. Shanks.

1451. *Hicoria laciniosa* (Mx. f.) Sarg. Shellbark (Hickory). Gnadenhutten, Tuscarawas Co. Chas. E. Miksch.

1458. Change name to *Populus tacamahacca* Mill. Tacamahac Poplar. The scientific name *P. balsamifera* L. has been found to belong to the Cottonwood.

1461. Change name to *Populus balsamifera* L. Cottonwood. The name *P. deltoides* Marsh. cannot be continued because Linnaeus originally applied *P. balsamifera* to the common Cottonwood and the names were later confused. The name Cottonwood has received various names and has been divided up into various varieties and species, but apparently they are for the most part forms which do not deserve specific rank.

1483.1. *Tetragonia expansa* Murr. New-Zealand-Spinach. Persistent and volunteer in gardens yearly for the last six years. Ada, Hardin Co. R. A. Dobbins.

1525. *Cucumis melo* L. Muskmelon. Along R. R. track. Near New Vienna, Clinton Co. Katie M. Roads.

1541. *Rhododendron maximum* L. Great Rhododenrdon. Tom's Hollow, Brush Creek Twp., Scioto Co. Conrad Roth and Floyd B. Chapman.

1548. *Gaultheria procumbens* L. Creeping Wintergreen. Washington Twp., Henry Co. R. E. Shanks.

1580. *Phlox stolonifera* Sims. Creeping Phlox. Waterloo State Forest, Athens Co. Walter P. Porter and P. S. Wamsley.

1593. *Convolvulus japonicus* Thumb. Japanese Bindweed. Hamilton, Butler Co. E. E. Good.

1625. *Gentiana procera* Holm. Smaller Fringed Gentian. Pickaway Co. Floyd Bartley and Leslie L. Pontius. In N. Y. Bot. Garden Herb. Reported by W. H. Camp.

1633. *Obolaria virginica* L. Pennywort. Tiverton Twp., Coshocton Co. F. W. Von Ohlen.

1641. *Asclepiodora viridis* (Walt.) Gr. Oblong-leaf Green Milkweed. "In the swamp land in a pasture." Washington Twp., Highland Co. Katie M. Roads. Scioto Co. Clyde H. Jones.

1645. *Asclepias purpurascens* L. Purple Milkweed. Reily Twp., Butler Co. E. E. Good.

1683. *Verbascum phlomoides* L. Clasping-leaf Mullen. In a pasture field on Wintersteen Run, Adams Co. A. R. Harper.

1685.1. *Penstemon laevigatus* (L.) Ait. Smooth Beard-tongue. Jackson Co. Leslie L. Pontius and Floyd Bartley. N. Y. Bot. Garden Herb. Reported by W. H. Camp.

1687.1. *Penstemon brevisepalus* Penn. Short-sepal Beard-tongue. Jackson Co. Floyd Bartley and Leslie L. Pontius. In N. Y. Bot. Garden Herb. Reported by W. H. Camp.

1700. *Gratiola virginiana* L. Round-fruited Hedge-hyssop. Jackson Co. Floyd Bartley and Leslie L. Pontius. In N. Y. Bot. Garden Herb. Reported by W. H. Camp.

1708. *Aureolaria pedicularia* (L.) Raf. Fernleaf False Foxglove. Plain Twp., Wood Co. R. E. Shanks.

1761.1. *Ruellia parviflora* (Nees) Britt. Slender Ruellia. Letart Twp., Meigs Co. Clyde H. Jones. Gallia Co. Floyd Bartley and Leslie L. Pontius.

1789. *Verbena angustifolia* Mx. Narrowleaf Vervain. Highland Co. Floyd Bartley and Leslie L. Pontius. In N. Y. Bot. Garden Herb. Reported by W. H. Camp.

1802. *Scutellaria serrata* Andr. Showy Skullcap. Waterloo State Forest, Athens Co. Also in Bedford Twp., Meigs Co. Walter P. Porter and P. S. Wamsley.

1805. Change name to *Scutellaria ovalfolia* Pers. *S. pilosa* Mx. is invalidated by the older *S. pilosa* Hill.

1825. *Perilla frutescens* (L.) Britt. Perilla. Eastern Adams Co. Arthur R. Harper.

1844. *Meehania cordata* (Nutt.) Britt. Meehania. Carbondale, Athens Co., and Bedford Twp., Meigs Co. W. P. Porter and P. S. Wamsley.

1888. *Aralia hispida* Vent. Bristly Sarsaparilla. Dundee, Tuscarawas Co. Don M. Brown.

1901. *Torilis anthriscus* (L.) Gmel. Erect Hedge-parsley. Hundreds of plants along R. R. near Hillsboro, also in Concord Twp., Highland Co. Katie M. Roads.

1925. *Conium maculatum* L. Poison-hemlock. Miller City, Putnam Co. C. J. Willard.

1985. *Triosteum aurantiacum* Bickn. Scarlet-fruited Horse-gentian. Near Zoar, Tuscarawas Co. Don M. Brown.

1994. *Lonicera sempervirens* L. Trumpet Honeysuckle. Shawnee Forest, Scioto Co. "Fairly common in the locality." Conrad Roth.

2076.1a. *Bidens polylepis retrorsa* Sherff. Large-bracted Tickseed. Brush Creek Twp., Scioto Co. Clyde H. Jones.

2099. *Gaillardia pulchella* Fong. Gaillardia. Washington Twp., Henry Co. R. E. Shanks.

2140. *Solidago riddellii* Frank. Riddell's Goldenrod. Joos Swamp, Hocking Twp., Fairfield Co. Chas. R. Goslin. Jackson Twp., Stark Co. Don M. Brown.

2148. *Aster schreberi* Nees. Schreber's Aster. Vinton Co. W. P. Porter and P. S. Wamsley.

2149.1. *Aster ianthinus* Burgess. Violet Wood Aster. Jackson Co. Floyd Bartley and Leslie L. Pontius. In N. Y. Bot. Garden Herb. Reported by W. H. Camp.

2170. Change name to *Aster ericoides* L. Dense-flowered Aster.

2176. Change name to *Aster glabellus* Nees. Steel-weed Aster.

2176.a. Change name to *Aster pilosus* Willd., Hairy Aster, and renumber as 2176.1.

2183. *Leptilon divaricatum* (Mx.) Raf. Low Horseweed. In an alfalfa field. Urbana, Champaign Co. Claud Neal, sent in by D. D. Dowds.

2189.2. *Eupatorium torreyanum* Short. Torrey's Thoroughwort. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

2191.1. *Eupatorium pubescens* Muhl. Hairy Thoroughwort. Jackson Co. Leslie L. Pontius and Floyd Bartley. In N. Y. Bot. Garden Herb. Reported by W. H. Camp. This species should probably be united with *E. rotundifolium.*

2209. *Anthemis tinctoria* L Yellow Dog-fennel. Near Boys' Industrial School, Fairfield Co. L M. Bloomfield. Marion Co. R. A. Dobbins.

2217. *Matricaria inodora* L Scentless Chamomile. In a pasture. Marion Co. R. A. Dobbins.

2219. *Matricaria matricarioides* (Less.) Port. Rayless Chamomile. Beside sidewalk, Columbus, Franklin Co.; Clifton Gorge, Green Co., and along interurban R. R. Track, Morefield Twp., Clark Co. John H. Schaffner.

2223. *Artemisia ludoviciana* Nutt. Western Mugwort. Spreading along a road on hilltop, from former planting. Union Twp., Clark Co. John H. Schaffner. Center Twp, along Portage R., Wood Co., apparently escaped, Center Twp., Wood Co. R. E. Shanks.

2240. *Tussilago farfara* (L.) Raf. Coltsfoot. Barnesville, Belmont Co. A large patch along a ditch at the side of the road. Emma E. Laughlin.

2254. *Onopordon acanthium* L. Scotch Thistle Many plants in waste ground. Rock quarries, Marble Cliff, Franklin Co. John H. Schaffner. Fairfield Twp., Butler Co. E. E. Good.

2283. *Hieracium florentinum* All. King-devil (Hawkweed). In a meadow. Barnesville, Belmont Co. Emma E. Laughlin.

2303. *Lactuca hirsuta* Muhl Hairy Lettuce. Dry woods. Liberty Twp, Jackson Co. Floyd Bartley and Leslie L. Pontius.

2307. *Lactuca saligna* L. Willow Lettuce. North of Celina, Mercer Co. John H. Schaffner.

Antarctic Biography

It is always refreshing to read of the lives of men who dare to die for an ideal—the goal of accomplishment. Edward Wilson, who accompanied Scott on his fatal expedition to the South Pole, was a man of moral fearlessness, great physical courage and the possessor of a "modesty which comes of a true sense of proportion."

The expedition adventures of Dr. Wilson (M. D) are of secondary importance in the book, the author's object being to give to the world the thoughts and feelings of a man of character.

Dr. Wilson's interest in birds has been strengthened by his association with fellow members of the British Ornithologists' Union—particularly, Sharpe, Selous, Thorburn and Lodge His chief talents were sketching ability and devotion to chosen objectives. He completed a series of panoramic sketches of Antarctic mountain ranges which were unique in the annals of polar exploration, and were later reproduced by the Royal Society. His pioneer observations of the Emperor Penguin recall those later made of the same species by members of the Byrd Expedition.

The book is not a great scientific or literary contribution—it is not intended to be. Quotations from diaries and journals of Dr. Wilson make up half the book. These bits of experiences and adventures are used to portray a character of inspiration, and to analyze the psychological and religious influences which shaped a life.

—*L. E. Hicks.*

Edward Wilson of the Antarctic, Naturalist and Friend, by George Seaver, with an introduction by Apsley Cherry-Garrard. xxxiv+301 pp. New York, E. P. Dutton & Co., 1937. $3.00.

A NEW GENUS AND FOUR NEW SPECIES OF CICADELLIDAE (HOMOPTERA) FROM THE UNITED STATES

DWIGHT M. DE LONG,
Department of Zoology and Entomology,
The Ohio State University

Genus **Orientus** n. gen.

Allied to *Phlepsius*. Elytra marked with ramose pigment lines. Vertex almost parallel margined, broadly rounded with a depressed transverse line back of margin. Vertex margin broadly rounded to front and obtusely angled with it. Male plates deeply notched on outer margins, forming a conspicuous tooth. Pygofers with long processes arising dorsally on inner margins near anal tube and extending apically and ventrally.

Type of Genus *Phlepsius ishidae* Mat.

Although described as a member of this genus, recent study has indicated that it is quite distinct from the other groups previously placed under the name *Phlepsius*.

Laevicephalus flabellum n. sp.

Resembling *flavovirens* in form, color and general appearance, but oedagus of male without recurved lateral processes at apex. Length 4.5–5 mm.

Vertex well produced and bluntly angled, about one-fourth wider between eyes than median length.

Color: Vertex yellow, recurved arcs from front on margin either side of apex brownish, pronotum green, bordered with yellow, scutellum yellow, elytra green. Face brown with pale arcs.

Genitalia: Female last ventral segment sloping to central produced, black tooth, truncate at apex which is produced more than one-half the length of segment. Male plates broad, rounded at apex to inner margins. Oedagus broadened at apex, broadly rounded with a short spine-like projection at either side of broadly rounded margin.

Holotype male, allotype female and male and female paratypes Eureka, California, June 23, 1934 (E. D. Ball), in Ball collection. Male and female paratypes in author's collection.

Phlepsius supinus n. sp.

Resembling *uhleri* in size and form but paler in color with oedagus longer and curved ventrally at apex. Length 4.5 mm.

Vertex parallel margined, broadly roundedly produced. More than three times as broad between eyes as median length. Vertex with thick margin.

Color: Vertex and scutellum tawny, vertex with a white spot at apex. Pronotum and elytra heavily marked with dark brown. Elytra with a brown spot on commissural line at middle and another at apex of clavus.

Genitalia: Male plates rather short and broad, shorter than pygofers. Oedagus bifurcate at apex. In lateral view with a long curved process extending caudally with the apex narrowed and recurved ventrally.

Holotype male collected at Battle Point, Virginia, June 22, 1918, by J. G. Sanders.

Chlorotettix aurum n. sp.

Resembling *suturalis* in general form and appearance but smaller with notched pygofer and four shorter terminal processes on oedagus. Length 7 mm.

Vertex roundedly produced, only slightly longer on middle than next the eye, about twice as broad as median length.

Color: Yellow, unmarked, elytra pale subhyaline, slightly darker along commissural line. Yellow beneath.

Genitalia: Male plates long, gradually tapered to rather acutely pointed apices. A brown mark in center of either plate at base as in *suturalis*. Male styles long and slender, apical half gradually tapered to blunt apices. Oedagus in lateral view curved, basal and apical ends directed dorsally. Apex with four long slender processes, two directed caudally and two slightly anteriorly directed dorsally. Pygofer notched on caudal margin, the portion dorsal to notch strongly pointedly produced. Two pairs of brushes of heavy spines extend from wall of pygofer into genital chamber and almost obscure apex of oedagus. Two of these are attached just below the notch on ventral apical portion and two are attached to dorsal wall above and anterior to notch.

Holotype male and paratype male, Carolina Beach, North Carolina, June 24, 1928, collected by the author.

Dikraneura lentus n. sp.

In general appearance resembling *carneola* but with vertex more bluntly angled and ventral caudal margin of pygofer produced and pointed. Length 3.5–4 mm.

Vertex bluntly angled, two and one-half times as broad as long. Produced two-thirds its length before anterior margins of the eyes.

Color: Dull green tinged with yellow. Vertex dull yellowish, pronotum, scutellum and elytra greenish gray, elytra subhyaline.

Genitalia: Female last ventral segment broadly roundedly produced. Male plates gradually narrowed to rather bluntly rounded apices. Pygofers rounded from dorsal margin to produced, sharply pointed apices of ventral margin. Oedagus with anterior process which is produced dorsally, and apex with four finger-like processes. Two extend dorsally beyond margin of pygofers and two recurve caudally and are directed ventrally.

Holotype male, allotype female and male and female paratypes from White Mt., Arizona, collected July 5, 1935, by F. H. Parker.

BOOK NOTICES

Two New Good Textbooks on Light

There have been for some time a number of textbooks on light which have attained the "standard" classification. Among these, perhaps, the most outstanding is "Physical Optics," by R. W. Wood, which though complete, is so burdened with information minute in character that it is useful mainly as a reference book.

McGraw Hill has undertaken to supply two books which would fill the need for adequate textbooks written with modern problems in mind. The authors and publishers are to be commended on their effort. In considering the problem it must be borne in mind that the subject is extraordinarily rich and minute in its complexity though not essentially difficult to master. The author's problem is therefore not so much one of exposition as it is one of organization and choice of material.

The first of these books is by G. S. Monk (University of Chicago) and entitled simply "Light—Principle and Experiments." It encompasses a larger area than the second book and offers no difficulties great enough to cause trouble to the average college sophomore or junior. Several errors have escaped the author's attention but these are on the whole rather trivial and of a nature to reveal themselves. The optical path through a Gregorian telescope on page 81 is an example of such an error. In the opinion of the reviewer, the book is admirably suited for a course on light given either for a quarter or a semester to students who have had one year of college physics.

The second book is by Jenkins and White (University of California) and entitled "Fundamentals of Physical Optics." It covers a more restricted part of the subject with greater thoroughness, and is on the whole the more difficult and better written of the two books. Its material could not be covered satisfactorily in one quarter or probably not even in one semester. The book presupposes the elementary calculus and is intended for seniors and first year graduate students.

It must be emphasized that both books are thoroughly modern and up-to-date not only in material but in points of view which have suffered some change in character since the great development of interest in atomic problems.

—*C. E. Hesthal.*

Light—Principles and Experiments, by George S. Monk. xi+477 pp. McGraw-Hill Book Company, Inc., New York, 1937.

Fundamentals of Physical Optics, by Francis A. Jenkins and Harvey E. White. xiv+453 pp. McGraw-Hill Book Company, Inc., New York, 1937.

Quantum Mechanics

Elements of Quantum Mechanics, by Saul Dushman, is an outgrowth of a set of lectures delivered in the summer of 1932 at Ohio State University. The book has been written for the student with little mathematical background and consequently contains in most instances detailed mathematical development.

In the first two chapters are discussed the early experiments which led to the quantum theory and the development of the Schrödinger equation. Subsequent chapters are devoted to potential barrier problems, Wilson-Sommerfeld quantum conditions, the problem of the harmonic oscillator, the rigid rotator and the hydrogen atoms in quantum mechanics and to the theory of perturbations. The final chapters are devoted to the hydrogen molecule, the theory of valence and to the radiation theory. At the end are several appendeces which should be most helpful to the reader—in particular the list of collateral reading.

Dr. Dushman's book can be recommended to the beginning student of quantum mechanics, but will probably be of little interest to students well versed in the subject.—*H. H. Neilsen.*

Elements of Quantum Mechanics, Saul Dushman. xiii+452 pp. New York, John Wiley & Sons, 1938. $5.00.

More Quantum Mechanics

Professor Kemble has succeeded unusually well in his new book, Fundamental Principles of Quantum Mechanics, in formulating many of the mathematical difficulties which confront the advanced student actively engaged in obtaining solutions to physical problems. In his endeavor he has provided a book on the subject far superior to the average and one which should be very useful to the student who has already had an elementary introduction to the subject.

Chapters I and II contain an historical account of the early beginnings of the theory and a discussion of the wave-particle dualism of the atom. In chapter III the Schrodinger equation for one dimensional problems is treated and as well the Kramers-Wentzel-Brillouin approximate solutions. Chapters IV to VIII are devoted to the mathematics of quantum mechanics; the theory of orthogonal functions and their relations to function space, the theory of linear operators and its connection with the general quantum mechanical dynamical variable The four following chapters concern themselves with the theory of measurement, matrix theory, perturbation theory and the radiation theory. The remaining two chapters are given over to an application of the theory discussed in the earlier chapters to the general problem of complex atomic spectra.

This book fills a very definite need and is enthusiastically to be recommended to students who wish to acquire more than a surface knowledge of the quantum theory.—*H. H. Neilsen.*

The Fundamental Principles of Quantum Mechanics, by Edwin C. Kemble. xviii+611 pp. New York, McGraw-Hill Book Co., 1937. $6 00.

Thermodynamics

Enrico Fermi's book, Thermodynamics, is an elaboration upon a set of lectures delivered at Columbia University in the summer quarter of 1936. The first four chapters of this work are devoted in the conventional way to elementary principles and subsequent chapters treat in much the usual manner such subjects: Thermodynamic Potentials, Gaseous Reactions, Thermodynamics of Dilute Solutions and the Entropy Constant. At the end of each chapter problems will be found, intended to illustrate to the student the principles already set forth.

The book contains only a little more than a hundred fifty pages and in this space a very great deal of material is covered; in fact one is perhaps made to feel a little too acutely that the work is in reality a set of lecture notes rather than a text book on the subject. For this reason one is led to suspect that this book will prove itself most suitable in a course where time is available for considerable classroom discussion and for further amplification on several topics by the instructor in the course.—*H. H. Neilsen.*

Thermodynamics, by Enrico Fermi. x+160 pp. New York, Prentice-Hall, 1937. $3.00.

THE OHIO JOURNAL OF SCIENCE

VOL. XXXVIII SEPTEMBER, 1938 No. 5

STUDIES IN ANTIBIOSIS BETWEEN BACTERIA AND FUNGI[1]

CONST. J. ALEXOPOULOS,
R. ARNETT, and
A. V. McINTOSH
Department of Biology, Kent State University

The observations reported herein are the first results of a series of studies in antibiosis between bacteria and fungi, which were begun in the Biological Laboratories of Kent State University in October, 1935. The aim of these investigations is to determine if any of several common species of bacteria are able to inhibit the growth of fungi when grown in close association with them in culture, and to obtain some information regarding the nature of such inhibition.

These studies were undertaken with a number of cultures of bacteria and fungi which were on hand for use in instructional work. The organisms employed are as follows:

Schizomycetes:

Staphylococcus aureus Ros.
Micrococcus ureae Cohn.
Serratia marcescens Bizio.
Klebsiella pneumoniae (Schr.) Trev.
Escherichia coli (Mig.) Cast. et Chalm.
Proteus vulgaris Hauser.
Alcaligenes faecalis Cast. et Chalm.
Bacillus subtilis Cohn.
Bacillus cereus Frank. et Frank.
Bacillus megatherium DeBary.
Actinomyces albus Krainsky.

[1]A resumé of this paper was read before the Ohio Academy of Science at Columbus, Ohio, at the annual meeting of the society in May, 1937.

Eumycetes:

- *Zygorhynchus mülleri* Vuill.
- *Glomerella cingulata* (Stonem.) Sp. et v. Schr.
- *Anthostomella* sp.
- *Physalospora cydoniae* Arn.
- *Gloesoporium affine* Sacc.
- *Gloeosporium musarum* Cke. et Mass.
- *Colletotrichum lindemuthianum* (Sacc. et Magn.) Bri. et Cav.
- *Botrytis tulipae* (Lib.) Hopk.
- *Cephalothecium roseum* Cda.
- *Volutella fructi* St. et H.

In order to determine the effect of the bacteria upon the growth of fungi, each bacterium was grown together with each fungus on dextrose agar, and on corn meal agar, in Petri dishes. The fungous inoculum was placed in the center of the Petri dish. At two centimeters from it, on opposite sides, the agar was inoculated with the bacterium to be tested. Fungi were inoculated at the same time as the bacteria except in experiments in which *Zygorhynchus mulleri* and *Anthostomella* were used. In these two cases, because of the rapid growth of the mycelium, it became necessary to inoculate the bacterium 24 to 36 hours before the fungus, so that the bacterial colonies could become established before the fungous colony was very large. Fungi which sporulated freely, were inoculated by means of a loopful of water suspension of spores. Others were inoculated by means of mycelial transfers. Bacteria were inoculated by using a small loopful of a heavy, water suspension of cells and dividing it between the two points of inoculation in the same Petri dish.

Twelve cc. of Difco agar were used to the Petri dish in all cases. The agar was neutralized with NaOH or HCl. pH determinations were made colorimetrically using a W. A. Taylor comparator. Measurements of fungous colonies were taken with a millimeter rule at intervals of 24 hours, beginning 24 hours after inoculation and continuing until a distinct inhibitory influence was evident, or until the fungous and bacterial colonies were in contact. All tests were carried out in triplicate. Two diameters at right angles to each other were measured on each fungous colony, and the average of the three colonies in each test was recorded. At the first sign of definite inhibition, the

shortest distance between the fungus and the inhibitor was measured. This distance is recorded as "Inhibitory distance."

Of the bacteria employed, *Serratia marcescens*, *Bacillus subtilis*, and *Actinomyces albus* inhibited the growth of fungi. All other bacteria had no appreciable effect upon the growth of any of the fungi against which they were tested. (Plates I and II).

In order to conserve space, only the figures pertaining to the tests with the inhibitor organisms are given in Table I, and contrasted with the controls in each case. The diameters of the fungous colony, are the averages for three cultures. The first figure is the diameter directly between the two bacterial colonies; the second is the diameter at right angles to the first. In the case of the controls, the averages of the minimum and maximum diameters of the three colonies in each test are recorded. The column marked "Inhibitory distance" gives the average minimum distance between the fungous colony and the inhibitor colonies at the time of the first evidence of definite inhibition.

From the figures given in Table I it will be seen that *Actinomyces albus* is the most universal inhibitor of the three under consideration. It inhibits all of the fungi against which it was tested, on both kinds of agar. *Bacillus subtilis* inhibits the growth of 5 of the 10 fungi, on dextrose agar, and that of 8 fungi on corn meal agar. *Serratia marcescens* inhibits the growth of 3 fungi on dextrose agar, and 5 fungi on corn meal agar.

The greatest single amount of inhibition was detected in the case of *Bacillus subtilis* against *Cephalothecium roseum* on corn meal agar. In several tests carried out, the conidia of the fungus used as inoculum, produced germ tubes, but failed to develop further. In one case, a colony was actually developed which, however, failed to reach a diameter exceeding 5 mm.

In all but one case, inhibition, when it occurred, was greater on corn meal agar than on dextrose agar. No correlation exists between rate of growth and degree of inhibition. Rapidly growing fungi may be inhibited as greatly as slowly growing fungi; slowly growing bacteria may inhibit as much as, or more than rapidly growing ones. The inhibitory effect was more pronounced on corn meal agar than on dextrose agar in spite of the fact that all three of the inhibitors grew much more luxuriantly on dextrose agar.

TABLE I

GROWTH OF TEN SPECIES OF FUNGI ON DEXTROSE AGAR AND CORN MEAL AGAR, GROWN IN ASSOCIATION WITH THREE SPECIES OF INHIBITOR BACTERIA, EXPRESSED IN TERMS OF AVERAGE DIAMETERS, IN MILLIMETERS, OF THREE CULTURES

DEXTROSE AGAR

Fungi	Inhibitor Organism—*Serratia marcescens*						
	Age of Fungous Colonies in Days						Inhibitory Distance
	1	2	3	4	5	6	
Z. mulleri + bacteria	15x15	39x39					
Control	12x14	40x40					
G. cingulata + bacteria		9x10	14x13	24x25	34x38		
Control		8x 8	17x18	28x29	38x38		
Anthostomella sp. + bacteria	22x23	65x66					
Control	20x21	64x65					
P. cydoniae + bacteria		18x18	28x37	28x44	29x52		2 mm.
Control		19x19	35x35	43x43	55x55		
G. affine + bacteria		12x12	21x21	27x28	33x34		
Control		13x13	21x21	30x30	34x35		
G. musarum + bacteria		21x21	38x38				
Control		20x21	38x38				
C. lindemuthianum + bacteria		17x17	32x44				
Control		17x18	44x45				
B. tulipae + bacteria		11x10	20x21	25x38	29x47		2 mm.
Control		9x 9	21x21	39x39	47x48		
C. roseum + bacteria		10x10	27x36	27x48	27x64		2 mm.
Control		10x10	34x36	51x53	62x65		
V. fructi + bacteria		8x 8	14x14	21x22	27x29	31x35	
Control		6x 6	12x12	20x20	26x26	31x32	
	Inhibitor Organism—*Bacillus subtilis*						
Z. mulleri + bacteria	17x18	41x41					
Control	12x14	40x40					
G. cingulata + bacteria		8x 8	15x16	26x28	35x37		
Control		8x 8	17x18	28x29	38x38		
Anthostomella sp. + bacteria	20x18	69x68					
Control	21x21	64x65					
P. cydoniae + bacteria		18x19	31x35	31x42			2 mm.
Control		19x19	35x35	43x43			
G. affine + bacteria		13x13	21x21	25x30	27x35	28x40	2 mm.
Control		13x13	21x21	30x30	34x35	39x40	
G. musarum + bacteria		20x20	33x36				
Control		20x21	38x38				
C. lindemuthianum + bacteria		18x17	39x44				3 mm.
Control		17x18	44x45				
B. tulipae + bacteria		9x10	20x20	32x36			
Control		9x 9	21x21	38x39			
C. roseum + bacteria		4x 4	10x11	14x19	14x26		17 mm.
Control		10x10	34x36	51x53	62x65		
V. fructi + bacteria		6x 7	12x12	16x19	19x25	20x29	3 mm.
Control		6x 6	12x12	20x20	26x26	31x32	

TABLE I—Continued

DEXTROSE AGAR—Continued

FUNGI	INHIBITOR ORGANISM—*Actinomyces albus*						
	AGE OF FUNGOUS COLONIES IN DAYS						INHIBITORY DISTANCE
	1	2	3	4	5	6	
Z. mulleri + bacteria	17x17	31x39	34x69				2 mm.
Control	12x14	34x35	68x71				
G. cingulata + bacteria		9x 9	19x19	22x30	27x40	30x51	5 mm.
Control		8x 8	17x18	28x29	38x38	47x48	
Anthostomella sp. + bacteria	20x20	25x65	27x90				5 mm.
Control	20x21	64x65	90x90				
P. cydoniae + bacteria		17x19	24x34	26x40	26x50		5 mm.
Control		19x19	35x35	43x43	55x55		
G. affine + bacteria		13x13	19x20	24x29	26x34	28x39	6 mm.
Control		13x13	21x21	30x30	34x35	39x40	
G. musarum + bacteria		21x22	30x40	30x54	30x78		3 mm.
Control		20x21	38x38	51x52	76x77		
C. lindemuthianum + bacteria		18x17	26x44	28x57	28x62		5 mm.
Control		17x18	44x45	55x57	62x64		
B. tulipae + bacteria		11x11	20x20	24x37	28x46	28x64	7 mm.
Control		9x 9	21x21	38x39	47x48	61x63	
C. roseum + bacteria		10x10	31x40	31x50	31x60		1 mm.
Control		10x10	34x36	51x53	62x65		
V. fructi + bacteria		7x 6	13x13	18x20	20x26	21x31	7 mm.
Control		6x 6	12x12	20x20	26x26	31x32	

CORN MEAL AGAR

	INHIBITOR ORGANISM—*Serratia marcescens*						
Z. mulleri + bacteria	19x18	40x42					
Control	13x13	36x36					
G. cingulata + bacteria		8x 9	16x15	26x25	34x34		
Control		7x 8	15x16	27x28	33x34		
Anthostomella sp + bacteria	15x16	29x50	33x81				3 mm.
Control	13x15	51x52	84x85				
P. cydoniae + bacteria		21x21	35x35				
Control		21x21	36x37				
G. affine + bacteria		11x12	18x20	25x30	30x38	34x45	7 mm.
Control		10x10	18x18	26x27	36x36	42x42	
G. musarum + bacteria		19x19	32x35	37x46			3 mm
Control		18x19	33x33	44x44			
C. lindemuthianum + bacteria		16x16	35x39				
Control		15x16	38x40				
B. tulipae + bacteria		14x15	23x24	37x38	45x47		
Control		15x15	24x24	38x38	46x46		
C. roseum + bacteria		8x 9	20x27	22x36	24x47		8 mm.
Control		8x 9	26x29	34x37	46x50		
V. fructi + bacteria		7x 7	12x12	17x18	23x25	26x31	3 mm.
Control		7x 8	12x13	18x19	23x24	30x30	

TABLE I—Continued

Corn Meal Agar—Continued							
Fungi	Inhibitor Organism—*Bacillus subtilis*						
	Age of Fungous Colonies in Days						Inhibitory Distance
	1	2	3	4	5	6	
Z. mulleri + bacteria	17x17	36x38					
Control	13x13	36x36					
G. cingulata + bacteria		9x 9	14x15	25x26	34x35		
Control		7x 8	15x16	27x28	33x34		
Anthostomella sp. + bacteria.	15x16	33x51	34x83				3 mm.
Control	13x15	51x52	84x85				
P. cydoniae + bacteria		21x21	30x35	37x42			3 mm.
Control.		21x21	36x37	41x42			
G. affine + bacteria		11x11	19x19	25x29	26x37	27x43	4 mm.
Control		10x10	18x18	26x27	36x36	42x42	
G. musarum + bacteria		19x19	29x34	37x45			3 mm.
Control		18x19	33x33	44x44			
C. lindemuthianum + bacteria		16x16	25x31	35x39			5 mm
Control.		15x16	38x40	49x51			
B. tulipae + bacteria		16x16	25x25	33x39	42x49		3 mm.
Control		15x15	24x24	38x38	46x46		
C. roseum + bacteria		0x 0	0x 0	0x 0	0x 0		20 mm
Control		9x 8	26x29	34x37	46x50		
V. fructi + bacteria		8x 8	11x11	14x18	17x24	19x29	11 mm
Control		7x 8	12x13	18x19	23x24	30x30	
	Inhibitor Organism—*Actinomyces albus*						
Z. mulleri + bacteria	21x21	25x33	29x64				7 mm.
Control	13x13	36x36	66x66				
G. cingulata + bacteria		8x 9	15x18	16x27	18x35	20x42	10 mm.
Control		7x 8	15x16	27x28	33x34	45x46	
Anthostomella sp. + bacteria.	14x16	16x37	17x63				11 mm.
Control	13x15	51x52	84x85				
P. cydoniae + bacteria		18x20	23x23	23x39	23x49		10 mm.
Control		21x21	36x37	41x42	49x50		
G. affine + bacteria		10x10	13x17	15x25	19x30	21x34	12 mm.
Control		10x10	18x18	26x27	36x36	42x42	
G. musarum + bacteria.		15x17	15x26	17x33	19x43		10 mm.
Control		18x19	33x33	44x44	63x64		
C. lindemuthianum + bacteria		13x16	15x34	16x42	16x47		12 mm
Control		15x16	38x40	49x51	57x58		
B. tulipae + bacteria		13x13	16x22	16x26	17x30	17x34	10 mm
Control		15x15	24x24	38x38	46x46	56x57	
C. roseum + bacteria		7x 8	18x23	21x31	23x41		10 mm.
Control.		8x 9	26x29	40x42	46x50		
V. fructi + bacteria		7x 7	9x12	9x15	9x16	10x16	13 mm.
Control		7x 8	12x13	18x19	23x24	30x30	

When these facts were established, experiments were begun to obtain some information regarding the cause of inhibition. Three factors which seemed important to investigate as probable causes of inhibition were: First, a change in the pH of the medium induced by the inhibiting organism; second, a food depletion of the medium by the inhibiting organism; third, a secretion of some soluble substance which was toxic to the fungi. All three of these factors have been reported in the literature (1, 2, 3, 4, 6, 7, etc.) as causes of one type of inhibition or another in microorganisms.

The experiments undertaken were limited to the effect of *Actinomyces albus* on the growth of *Colletotrichum lindemuthianum*, on dextrose agar and nutrient agar prepared as follows: Fifteen flasks, each containing 100 cc. of neutral Difco dextrose broth, were inoculated with *Actinomyces albus*, one every two days. The organism was allowed to grow until thirty days had elapsed from the time of the inoculation of the first flask. Thus, a series of flasks was obtained which contained *Actinomyces* colonies ranging in age from 2 to 30 days. Another series of flasks containing Difco nutrient broth was treated in the same manner. At the end of the thirty-day period, the organism was removed from the broth by filtration through filter paper. The water lost by evaporation was added, and the liquid in each flask was divided into two 50 cc. portions. To one of these portions, the same proportion of dehydrated medium was added as was originally used in the preparation of the medium, to replace that which had been used by the *Actinomyces*. Additional food was withheld from the second 50 cc. portion; 1½% agar was added, and the media were distributed into test tubes and sterilized in the autoclave at fifteen pounds for fifteen minutes. The agars to which more food was added shall be referred to henceforth as "Fortified-dextrose-inhibitor agar" and "Fortified-nutrient-inhibitor agar." The agars from which additional food was withheld shall be referred to as "Dextrose-inhibitor agar" and "Nutrient-inhibitor agar."

pH determinations showed that the pH varied from 6.5 to 8.8 in the dextrose agars containing inhibitor filtrate, and from 6.4 to 8.8 in the corresponding nutrient agars. A series of dextrose agar and nutrient agar tubes of various pH values corresponding to those of the agars prepared from the *Actinomyces* filtrates, was then prepared. These served as

TABLE II

EIGHT DAYS GROWTH OF *Colletotrichum lindemuthianum* IN FORTIFIED-DEXTROSE INHIBITOR AGAR (COLUMN A), DEXTROSE-INHIBITOR AGAR (COLUMN B), AND DEXTROSE AGAR (CONTROL), EXPRESSED IN AVERAGE MAXIMUM DIAMETERS, IN MILLIMETERS, OF THREE CULTURES

Age of *Actinomyces*-Culture Filtrate from which Inhibitor Agars were Prepared	A		CONTROL		B		CONTROL	
	pH	Diameter in mm.	pH	Diameter in mm.	pH	Diameter in mm.	pH	Diameter in mm.
2 days	7.2	83	7.2	81	6.5	66	6.5	84
4 "	7.2	84	7.2	81	6.9	66	6.9	83
6 "	7.2	62	7.2	81	7.1	58	7.1	82
8 "	7.7	37	7.7	79	7.6	25	7.6	80
10 "	7.7	29	7.7	79	7.6	17	7.6	80
12 "	8.2	22	8.2	78	7.8	21	7.8	80
14 "	8.0	23	8.0	79	8.0	26	8.0	79
18 "	8.4	22	8.4	80	8.3	28	8.3	80
20 "	8.5	18	8.5	77	8.4	18	8.4	80
22 "	8.6	19	8.6	78	8.5	18	8.5	77
24 "	8.8	21	8.8	76	8.8	24	8.8	76
26 "	8.8	18	8.8	76	8.8	19	8.8	76
28 "	8.8	18	8.8	76	8.8	19	8.8	76
30 "	8.8	18	8.8	76	8.8	18	8.8	76

TABLE III

EIGHT DAYS GROWTH OF *Colletotrichum lindemuthianum* IN FORTIFIED-NUTRIENT INHIBITOR AGAR (COLUMN A), NUTRIENT-INHIBITOR AGAR (COLUMN B), AND NUTRIENT AGAR (CONTROL), EXPRESSED IN AVERAGE MAXIMUM DIAMETERS, IN MILLIMETERS, OF THREE CULTURES

Age of *Actinomyces*-Culture Filtrate from which Inhibitor Agars were Prepared	A		CONTROL		B		CONTROL	
	pH	Diameter in mm.	pH	Diameter in mm.	pH	Diameter in mm.	pH	Diameter in mm.
2 days	6.5	50	6.5	49	6.4	55	6.4	53
4 "	6.7	53	6.7	55	7.0	54	7.0	49
6 "	7.5	29	7.5	47	7.6	29	7.6	48
8 "	7.9	26	7.9	45	8.0	31	8.0	43
10 "	7.8	29	7.8	47	8.1	28	8.1	43
12 "	8.3	18	8.3	44	8.6	21	8.6	43
14 "	8.2	19	8.2	44	8.6	24	8.6	43
18 "	8.5	0	8.5	44	8.7	15	8.7	40
20 "	8.4	15	8.4	43	8.8	15	8.8	39
22 "	8.4	15	8.4	43	8.8	16	8.8	39
24 "	8.4	16	8.4	43	8.8	16	8.8	39
26 "	8.4	19	8.4	43	8.8	12	8.8	39
28 "	8.4	0	8.4	43	8.8	22	8.8	39
30 "	8.4	15	8.4	43	8.8	13	8.8	39

controls in testing the possibility that a change in pH was responsible for inhibition. After sterilization, the different agars were poured into Petri dishes and three plates of each kind of agar were inoculated with a loopful of a heavy, water suspension of *Colletotrichum lindemuthianum*. The colonies resulting were measured every 24 hours for eight successive days. The results are summarized in Tables II and III.

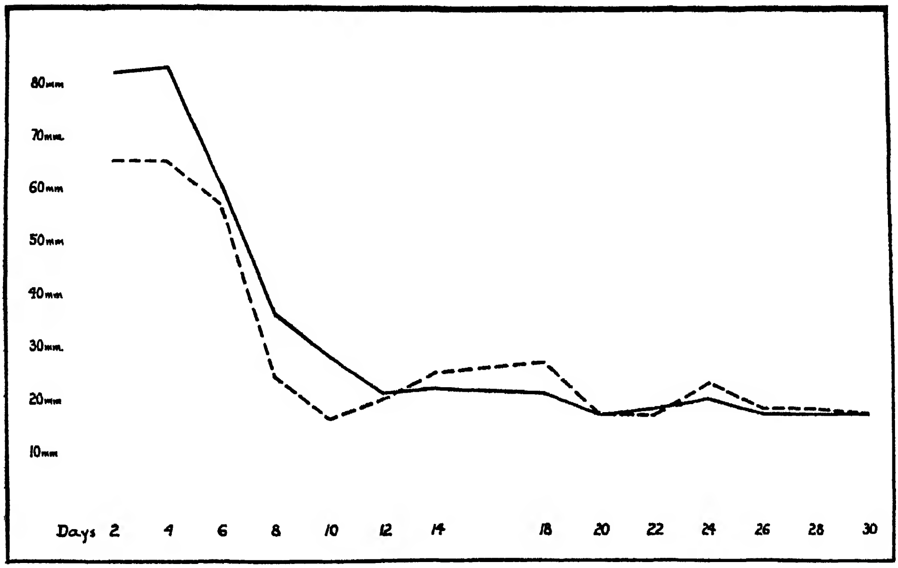


Fig. 1. Eight days growth of *C. lindemuthianum* on Dextrose-inhibitor agar and Fortified-dextrose-inhibitor agar, both prepared from filtrates in which *Actinomyces* had grown for different periods of time.
——————Fortified-dextrose-inhibitor agar.
---------------Dextrose-inhibitor agar.

The results of these experiments establish the fact that the presence of the living *Actinomyces* itself is not necessary for the inhibition of fungous growth since sterilized filtrates of *Actinomyces* cultures produce similar inhibitory effects. As the brief discussion which follows will point out, neither food depletion of the medium (Fig. 1), nor a change in pH brought about by the *Actinomyces* (Fig. 2), is responsible for the inhibition of growth of *Colletotrichum lindemuthianum*. It seems quite probable, therefore, that the antibiotic phenomena herein described are due to the presence of some substance which is toxic to the fungus.

An analysis of the figures in Tables II and III reveals that food depletion of the medium by the *Actinomyces* was not a factor in the inhibition of growth of *C. lindemuthianum*. A comparison of columns A and B in Table II shows that the fungus grew better on fortified-dextrose-inhibitor agar prepared from filtrates of *Actinomyces* cultures 2 to 10 days old than on dextrose-inhibitor agar prepared from filtrates of *Actinomyces*

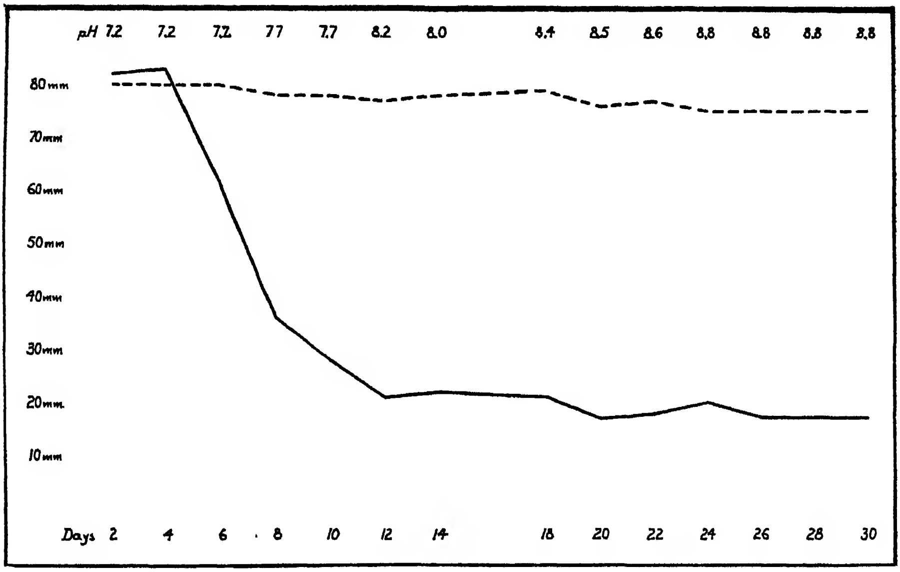


Fig. 2. Eight days growth of *C. lindemuthianum* on Fortified-dextrose-inhibitor agar prepared from filtrates in which *Actinomyces* had grown for different periods of time, compared with controls of comparable pH values.
——————Fortified-dextrose-inhibitor agar.
---------------Control, Dextrose agar.

cultures of similar ages. Since each 50 cc. portion of fortified filtrate received the same amount of additional dehydrated medium, and since food material already present was inversely proportional to the age of the colonies grown, the amount of food material in the fortified-dextrose-inhibitor agar varied up to almost double the original amount. In the inhibitor agars containing a small amount of inhibitory substance, an increase in growth due to greatly increased food supply is evident. However, with an increase in amount of inhibitory substance, variation in food supply does not seem to influence growth. This is indicated by the similar size of the colonies on fortified-

dextrose-inhibitor agar and dextrose-inhibitor agar made from the 12 to 30 day old culture filtrates.

From a comparison of the figures in Tables II and III it is evident that, in the presence of a large amount of food and a relatively small amount of inhibitory substance, the increase in growth of the fungus is entirely due to the dextrose contained in the food, the effects of which overbalance the inhibitory effects of the toxic substance. Dextrose agar and nutrient agar differ in composition only in that the former contains dextrose.

Although it cannot be denied that *C. lindemuthianum* apparently grows slightly better in an acid medium than in an alkaline one, as indicated by the growth of the controls, still the effect of pH is too slight to be considered as a factor in antibiosis between the organisms under consideration.

The antibiotic phenomena herein recorded, are quite probably due either to the secretion of a substance by the inhibitor organism, which is toxic to the fungus, or to the production of such a substance through an alteration of the medium by chemical reaction. This toxin is soluble in water, diffusible through agar, and to a large degree, at least, thermostable.

Organisms belonging to the genus *Actinomyces* have been reported in the literature as inhibiting the growth of fungi. Porter (5) mentions *Actinomyces* as a strong inhibitor of fungal growth. Millard and Taylor (4) report antagonism between two Actinomycetes in the soil, and Tims (3) has studied an Actinomyces which secretes a toxic substance which inhibits the growth of Pythium. During the past few years, the senior writer has observed that colonies of organisms belonging to this genus, occurring as contaminations in Petri dishes in the routine laboratory work with fungi, frequently inhibited the growth of many different fungi. Experiments, the results of which will be published soon, indicate that a large number of species of *Actinomyces* exhibit this property.

ACKNOWLEDGMENTS

The writers wish to express their appreciation to Prof. H. A. Cunningham, Head of the Department of Biology, Kent State University, for his continued interest and help during the progress of this investigation; to Dr. M. B. Palmer, of the

Department of Physical Science, Kent State University, for his help with certain phases of the work; to Dr. Francis Clark, of the Department of Bacteriology, University of Illinois, for supplying the bacterial cultures, and to all others who in any way contributed in the preparation of this paper. The photographs were prepared by Prof. J. T. Johnson, Department of Agriculture, Kent State University, to whom the writers are grateful.

LITERATURE CITED

(1) **Broadfoot, W. C.** Studies on foot rot and root rot of wheat. II. Cultural relationships on solid media of certain microorganisms in association with *Ophiobolus graminis* Sacc. Can. Jr. Res., 8: 542–552. 1933.
(2) **Chambers, W. H.** Studies in the physiology of the fungi. XI. Bacterial inhibition by metabolic products. Ann. Mo. Bot. Gard., 7: 249–289. 1920.
(3) **Fleming, Alexander.** On the antibacterial action of cultures of a Penicillium, with special reference to their use in the isolation of *B. influenzae*. Brit. Jr. Exp. Path., 10: 226–236. 1929.
(4) **Millard, W. A., and Taylor, C. B.** Antagonism of microorganisms as the controlling factor in the inhibition of scab by green-manuring. Ann. Appl. Biol., 14: 202–216. 1927.
(5) **Porter, C. L.** Concerning the characters of certain fungi as exhibited by their growth in the presence of other fungi. Am. Jr. Bot., 11: 168–188. 1924.
(6) **Reid, R. R.** Some properties of a bacterial inhibitory substance produced by a mold. Jr. Bact., 29: 215–221. 1935.
(7) **Tims, E. C.** An Actinomycete antagonistic to a Pythium root parasite of sugar cane. (Abst.) Phytopath., 22: 27. 1932.

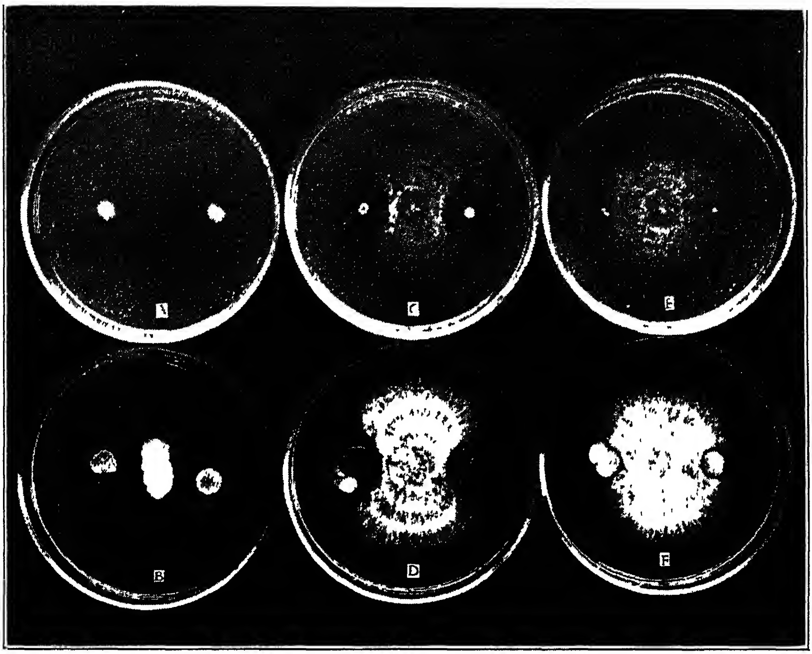
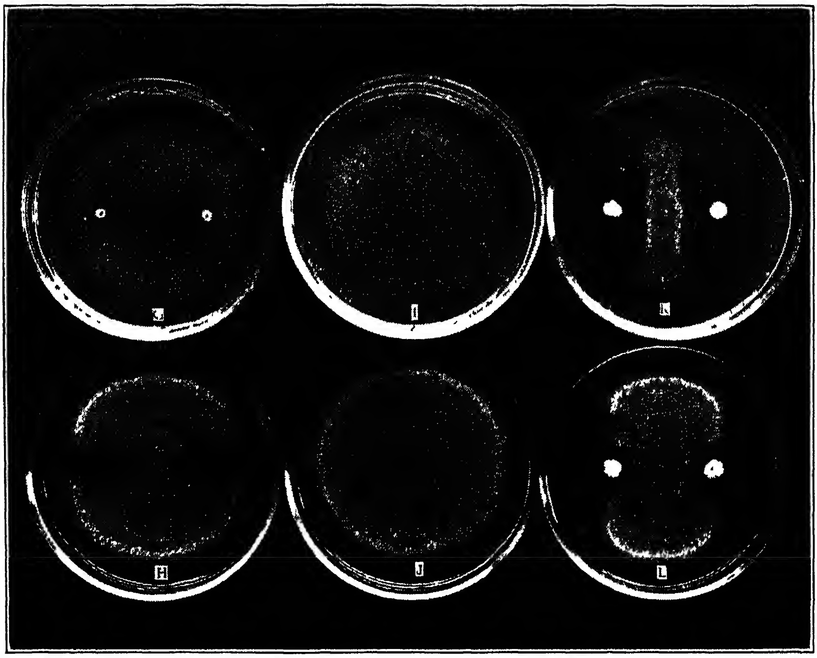


Fig. A. Complete inhibition of *Cephalothecium roseum* by *Bacillus subtilis* on corn meal agar.

Fig. B. Inhibition of *Cephalothecium roseum* by *Bacillus subtilis* on dextrose agar.

Figs. C, D. *Serratia marcescens* inhibiting growth of *Cephalothecium roseum* on corn meal agar (C) and dextrose agar (D).

Figs. E, F. *Alcaligenes faecalis* growing together with *Cephalothecium roseum* on corn meal agar (E) and dextrose agar (F). No inhibitory effect.



Figs. G, H. *Serratia marcescens* growing together with *Colletotrichum lindemuthianum* on corn meal agar (G) and dextrose agar (H). No inhibitory effect.

Figs. I, J. *Colletotrichum lindemuthianum*. Controls on corn meal agar (I) and dextrose agar (J).

Figs. K, L. *Actinomyces albus* inhibiting growth of *Colletotrichum lindemuthianum* on corn meal agar (K) and dextrose agar (L).

LIZARDS IN INSECT CONTROL

GEORGE F. KNOWLTON
Utah Agricultural Experiment Station

Lizards consume large numbers of injurious insects each year, thus constituting an important biological factor in environmental resistance. The extent of the benefit derived from lizards depends upon a number of factors, including (1) the abundance and distribution of lizards in a given area, and (2) the abundance and availability of the insect pests as compared with the availability of other acceptable food.

The feeding habits of any particular lizard species may be such as to make it especially useful or useless in the control of a particular insect pest. For instance, the larger lizards usually fed more extensively upon caterpillars, grasshoppers and larger insects, often disregarding tiny insects such as beet leafhoppers. On the other hand, several of the smaller lizard species, and to a less extent immature specimens of some of the larger lizards, fed more readily upon small insect pests if such occurred in abundance.

A number of agricultural insect pests breed in areas frequented by lizards and are extensively fed upon by these animals. This often results in a perceptable limitation of pest multiplication, with resulting benefits to agriculture.

Satisfactory estimates of lizard population density are difficult to make. Several seasons of study of small tracts of land in Tooele County, Utah, led the writer to conclude that populations of from fifty to four hundred northern brown shouldered utas per acre were not unusual in favorable breeding and feeding locations. Where small areas of unusual insect abundance occur in desert areas, such as on narrow strips of succulent roadside Russian thistle bordered on both sides by large dry areas of shadscale, high lizard populations have been observed especially during the evening feeding period shortly before sunset. This condition was particularly evident in the case of *Uta stansburiana stansburiana*. The data which follow relate to lizards collected in Utah.

Coleonyx variegatus (Baird). Two specimens of the banded gecko were collected at St. George, April 26, 1935, by C. F. Smith. Recognizable stomach contents consisted of 1 leafhopper; 2 beetles, 3 Lepidoptera, caterpillars; and 1 spider.

Crotaphytus collaris baileyi (Stejneger). The western collared lizard was usually collected upon the top of boulders on range land. Most of the specimen's stomachs were well distended with insect food. Grasshoppers, caterpillars and ants are three of the groups of insects most destructive to range plants; the first two had been fed upon commonly by the specimens examined. An examination of 93 stomachs showed 50 Lepidoptera to be present, 47 being caterpillars in 47 stomachs; 85 Coleoptera in 29 stomachs; 168 Orthoptera in 49 stomachs, 106 being nymphs, and nearly all of the specimens being grasshoppers; 11 Hemiptera in 7 lizards; 22 Diptera in 9 stomachs; 19 Homoptera in 7 stomachs, 18 being cicadas; 168 Hymenoptera in 39 lizards, only 19 being ants in 3 specimens; 1 Odonata; 3 Neuroptera; and 9 spiders in as many stomachs. In addition, one stomach contained 95 parasitic roundworms.

Crotaphytus wislizenii (Baird and Girard). The leopard lizard is another range species, which has an apparent "preference" for larger insects, particularly grasshoppers. Stomachs of 92 specimens were examined, showing 213 Orthoptera present in 87 stomachs, 62 being nymphs in 28 stomachs, all but a few of the specimens being grasshoppers; 14 Lepidoptera in 8 stomachs, all caterpillars; 4 Hemiptera; 3 Homoptera, cicadas; 8 Coleoptera in 6 stomachs; 13 Diptera in 11 stomachs, 10 of which were robber flies; 20 Hymenoptera in 14 stomachs, only 4 of which were ants; 5 spiders in as many lizards; and 2 round worms in one stomach. Federal entomologists estimated that $2,000,000 worth of poison bait would be needed to control the grasshoppers during 1937 in the western United States, and the Federal Government appropriated funds to make effective control possible. Lizards eating from one to several grasshoppers each day do much to retard grasshopper abundance wherever such lizards and grasshoppers occur together in abundance.

Callisaurus draconoides ventralis (Hallowell). The stomachs of 35 desert gridiron-tailed lizards were examined, the total contents consisting of 11 Orthoptera, grasshoppers, 6 being nymphs; 18 Neuroptera, 14 being ant lion larvae, and 4 aphis lions; 23 Isoptera in 1 stomach; 33 Hemiptera in 11 stomachs, 13 false chinch bugs and 13 Pentatomidae being the principal injurious forms; 12 Homoptera, 16 being leafhoppers, of which 4 in four stomachs were beet leafhoppers, and 4 aphids; 21 Coleoptera, including 1 Buprestidae, 4 Chrysomelidae, and 2 Scarabaeidae; 55 Lepidoptera in 15 stomachs, all but two being caterpillars; 88 Hymenoptera in 23 stomachs, only 10 of which were ants in 3 stomachs; 29 Diptera in 7 stomachs; 49 Arachnida in 16 stomachs; besides 6 plant blossoms and one plant leaf. This lizard evidently selects a wider variety of food than some of the less active species.

Uta levis Stejneger. The Rocky Mountain tree uta differs to some extent in food habits from its more common relative, *Uta s. stansburiana*. An examination of the stomachs of 44 *Uta levis* showed them to contain 3 Orthoptera, grasshoppers; 16 Hemiptera; 16 Homoptera, 6 being leafhoppers, of which two were beet leafhoppers in two stomachs; 30 Diptera, 11 being Calliphoridae; 28 Coleoptera, 1 being a larva;

21 Lepidoptera, of which 18 were caterpillars; 2 Thysanura; 70 Hymenoptera, 36 being ants in 11 stomachs; besides 11 Arachnida.

Uta stansburiana stansburiana (Baird and Girard). The northern brown shouldered uta feeds to a considerable extent upon small insects, although nymphal and adult grasshoppers occur rather commonly in its diet. An examination of 3,541 stomachs of this species showed the following food material to be in recognizable condition: 1 Thysanura; 635 Collembola; 1,093 Orthoptera, 749 being nymphs, of which 6 were Mantidae, 3 Gryllidae, most of the others being grasshoppers; 305 Isoptera or termites; 27 adult and 60 nymphal Neuroptera; 1 Ephemeridae; 23 Odonata; 85 Thysanoptera; 3,349 Hemiptera, including 51 adult *Lygus elisus* and *L. hesperus*, 7 lygaeid nymphs, 53 Pentatomidae, 682 adult and 55 nymphal *Nysius ericae* or false chinch bugs; 4,470 adult and 14,221 nymphal Homoptera, of which 2,713 were adult and 7,971 nymphal beet leafhoppers, *Eutettix tenellus* (Baker), besides 381 adult and 90 nymphal leafhoppers of other species, 14 Fulgoridae, 3 Cercopidae, 11 Membracidae, 1,323 aphids, 6 psyllids, and 22 Coccidae; 346 adult and 101 larval Coleoptera, including 6 Staphlynidae, 5 Cucujidae, 60 Chrysomelidae, 1 Scolytidae, 3 Curculionidae, 7 Tenebrionidae, 9 Melyridae, 2 Buprestidae, 65 Scarabaeidae, 10 adult and 2 larval Elateridae, 17 Silphidae, 1 Meloidae, and 2 Dermestidae; 708 Lepidoptera, all but 12 being caterpillars, including a large number of diamond back moth larvae; 304 adult and 454 larval Diptera, including 128 *Chloropisca glabra*, 10 Calliphoridae, 40 mosquitoes, 11 Muscidae, 15 Asilidae, 18 Chironomidae, 5 Tipulidae, 3 Tabanidae, 1 Simuliidae; 2,670 Hymenoptera, including 2,522 ants, 61 Chalcididae, 17 Sphecidae, 18 Apidae, 13 Ichneumonidae, 6 Braconidae, 10 Chrysididae, 10 Andrenidae, 1 Dryinidae, and 7 Vespidae; a number of Arachnida and several plant fragments also were present in the stomachs. An examination was made of 4,021 brown shouldered utas collected among Russian thistle, *Atriplex rosea*, and other hosts of the beet leafhopper, during the seasons of 1930 to 1935, inclusive. It was found that 2,249, or approximately 55.96 percent of the stomachs contained *Eutettix tenellus*, the total number of beet leafhoppers being 10,576 nymphs and 5,390 adults, or 15,966 in all. With lizard populations in desert breeding areas of the beet leafhopper estimated at from 50 to 400 per acre in various Tooele County, Utah, areas and the average being 7.09 beet leafhoppers for each stomach containing *E. tenellus*, this lizard seems to be an important aid to the agriculturists of the west.

Sceloporus graciosus graciosus (Baird and Girard). An examination of 1,332 sagebrush swifts, collected among sagebrush, rabbit brush, Russian thistle, and miscellaneous other plants, showed the following to be present: 2 Collembola; 203 adult and 289 nymphal Orthoptera, of which 4 were Gryllidae, nearly all of the others being grasshoppers; 89 Isoptera; 17 adult and 11 larval Neuroptera, 7 being Chrysopidae; 1 Odonata; 5 Thysanoptera; 672 adult and 809 nymphal Homoptera, of which 120 were adult and 122 nymphal beet leafhoppers, besides 119 other leafhoppers, 7 Cercopidae, 1 Membracidae, 601 aphids, 5 Fulgoridae, 1 Chermidae, and 1 Coccidae; 642 adult and 809 nymphal

Hemiptera, including 257 adults and 382 nymphs of the false chinch bug, 18 adult and 26 nymphal *Lygus elisus* and *L. hesperis* combined, 68 Pentatomidae, 12 Tingidae, as well as 45 adult and 5 nymphal *Geocoris decoratus*, an insect predator of the beet leafhopper; 169 adult, 602 larval, and 2 pupal Lepidoptera; 314 adult and 20 maggots of Diptera, including 6 Asilidae, 34 *Chloropisca glabra*, 6 Chironomidae, 5 Muscidae, 2 Calliphoridae, 2 mosquitoes, 1 horse fly, as well as 6 Sarcophagidae, 4 Tachinidae, and 1 Pipunculidae; 540 adult and 79 larval Coleoptera, including 136 Chrysomelidae, 17 Staphlynidae, 1 Melodiae, 6 Elateridae, 18 Scarabaeidae, 17 weevils, 1 Histeridae, 2 Cucujidae, 7 Tenebrionidae, 2 Dermestidae, 3 Buprestidae, as well as 109 ladybird beetles and 53 Carabidae; 3,357 Hymenoptera, 2,756 being ants, 10 Chalcididae, and such beneficial forms as 14 Ichneumonidae and 15 honey bees. In addition was recognized 189 spiders and mites; 1 scorpion; 1 small lizard, a *Sceloporus g. graciosus*, 83 round worms, 9 insect eggs; 2 mollusc shells; and a few plant fragments, the latter apparently accidentals.

Sceloporus magister Hal. Desert scaly lizards contained numerous insects in the 44 stomachs examined, recognizable material being: 7 Orthoptera in 5 stomachs; 1 Isoptera; 2 Neuroptera; 10 Hemiptera in 5 stomachs, 4 being false chinch bugs; 13 Homoptera in 3 stomachs; 88 Coleoptera in 23 stomachs; 83 larval Lepidoptera in 16 stomachs; 4 Diptera; 733 Hymenoptera in 33 stomachs of which 698 were ants in 28 stomachs. In addition 7 spiders; and 19 parasitic roundworms were found in 4 stomachs.

Cnemidophorus tessellatus tessellatus (Say). Desert whiptail lizards are common in a number of sections of Utah. The stomachs of 326 specimens were examined; these contained: 117 Neuroptera in 50 stomachs, 67 being Myrmelionidae in 30 stomachs, and 5 aphis lions; 1,643 termites in 39 stomachs; 262 Orthoptera in 113 stomachs, including 52 adult and 188 nymphal grasshoppers, 4 Mantidae, 16 crickets in 13 stomachs, and 1 phasmid; 75 Hermiptera in 30 stomachs, including 7 false chinch bugs, 13 pentatomids, 2 mirids and 2 tingids; 388 Homoptera in 57 stomachs, including 36 adult and 23 nymphal beet leafhoppers in 15 stomachs, 31 leafhoppers of other species, 11 Fulgoridae, 11 cicadas, 27 coccidae in 3 stomachs, 9 aphids in 3 stomachs, 70 adult and 62 nymphal psyllids in 5 stomachs; 223 Coleoptera in 112 stomachs, including 21 Tenebrionidae in 16 stomachs, 22 Scarabaeidae in 20 stomachs, 3 weevils, 32 Chrysomelidae in 5 stomachs, and 16 long horned beetles in 3; 111 Diptera in 50 stomachs, 2 being larvae, and 37 pupae; 775 Lepidoptera in 186 stomachs, 731 being caterpillars in 169 lizards and 27 pupae, 23 *Plutella maculipennis* larvae being found in the stomach of one specimen collected among *Cheirinia repanda*; 43 Hymenoptera in 28 stomachs, 33 being ants. Also contained were 93 spiders, 2 mites, and 1 small *Uta s. stansburiana*.

BASIDIOMYCETES OF THE CHAGRIN RIVER DISTRICT OF NORTHERN OHIO

MRS. HARVEY C. BINGHAM
Chagrin Falls, Ohio

The following notes are a preliminary contribution to the knowledge of the fungi in the Chagrin River district of Northern Ohio. Only the Basidiomycetes are dealt with in this paper. Two-thirds of these were found on "Vallevue Farm," the former estate of Judge Andrew Squire, located in the north-eastern section of Cuyahoga County. The rest were collected upon the farm of Harvey Bingham, Glen Rock, Bainbridge Township, Geauga County.

"Vallevue Farm" includes over two hundred and fifty acres of rolling fields, pastures and woodland. It has recently come into the possession of Western Reserve University, whose Biological Department expects to make an intensive study of the flora and fauna found there. The woodland is primarily beech and sugar maple. The most northern woods has been untouched for ten or twelve years, and most of the trees are over fifty years of age. Through part of the woodland a small stream has cut a deep ravine through the shale. Here beech, maple, dead chestnut, hemlock, birch and tulip are found.

Soil acidity varies from 3.7 pH under the hemlocks to an average of 4 pH in the woodland and ravine, and 5 pH in the open. Rainfall in this area is usually greatest in April, when there is over two inches, with an average of one inch in both January and September.

The collecting ground in Bainbridge Township is similar to that of the Squire property. Beech and maple predominate, with birch, ironwood and black cherry common. The land is rolling, with ravines and small streams.

The fungi have been photographed either in their natural environment or soon after collection. Sixty lantern slides and photographs of the Squire Estate fungi are on file in the Biological Department of Western Reserve University. Specimens of the Agaricaceae from the Squire Estate are there, also. The Polyporaceae, Thelaphoraceae, Hydnaceae, and Gasteromycetes are in the writer's collection. The Geauga County fungi are in the Oberlin College Herbarium.

H. C. Beardslee has determined the rarer Agariacaceae, and L. O. Overholts and F. O. Grover many of the Polyporaceae. Unusual spore measurements and other striking characteristics have been noted. The frequency of occurrence is indicated by the letters C for common, I for infrequent, and S for a single collection.

I. Cuyahoga County, Squire Estate Collections.
. Fifty-six species are represented.

Amanita phalloides Fries.
Beardslee says, "Volva with free margin, spores globose, 7–9 μ." S.
Clitocybe clavipes Fries. S.
Clitopilus abortivus Berk. and Curt.
Normal specimens, found with abortive forms, had spores salmon in mass, nucleate, elongated angular, 6.4–7 x 4–4.8 μ. I.
Collybia radicata Fr. S.
Collybia semitalis Fr.
Beardslee says, "This is a very interesting specimen. . . . In the dried specimens the spores are 5–6 μ. long, smaller than my measurements of fresh spores (7–9 μ). Your plant agrees in having the gills turn yellow when cut, and apparently they have blackened somewhat." I.
Coprinus micaceus Fr.
Spores 4.8–6.4 x 8–9 μ., purple black. Found in good condition as late as December first. I.
Flammula spumosa Fr.
Spores 8–10 x 5–6 μ., smooth, brown. S.
Hypholoma sublateritium Fr.
Spores 6–7 x 3.5–4 μ. C.
Lentius vulpinus (Sow.) Fr.
Spores 2.5–3.5 μ, ovoid, hyaline, white in mass. On sugar maple. S.
Lepiota procera Fr. S.
Leptonia serrulata Fr.
Beardslee says, "Spores angular, 7–9 x 4–5 μ." S.
Marasmius fagineus Morgan. I.
Panus stipticus Fr. C.
Pholiota adiposa Fr.
Spores obovoid, 8–10 x 5–7 μ, ochre, smooth. I.
Pleurotus sapidus Kalch.
Spores 7–10 x 4–4.5 μ, oblong, smooth. I.
Schizophyllum commune Fr. C.
Hydnochaete olivaceum (Schw.) Banker. I.
Hydnum ochraceum (Pers.) Fr.—*Steccherinum ochraceum* (Pers.) S. F. Gray. I.
Hydnum macrodon Pers. ex Fries.—*Oxydontia macrodon* (Fr.) Miller. I.
Peniophora cinerea (Fr.) Cke. C.
Solenia anomala (Pers.) Fr. S.
Stereum cinerascens (Schw.) Massee. C.
Stereum rameale Schw. C.

Stereum hirsutum (Willd.) Fr. C.
Stereum lobatum (Kuntze) Fr. C.
Stereum frustulosum (Pers.) Fr. C.
Thelephora pallida (Pers.) Fr. I.
Exidia glandulosa Fr. I.
Daedalea unicolor (Bull.) Fr.—*Cerrena unicolor* (Bull.) Murr.
Spores ovoid, 4–6 x 3–4 μ, hyaline, smooth; on beech. C.
Daedalea confragosa (Bolt.) Fr.
Spores 4–6 x 2 μ, on maple. I.
Fomes applanatus (Pers.) Wallr.—*Elfvingia megaloma* (Lév.) Murr.
Spores 7–8 x 6 μ, ovoid, smooth, brownish, on sugar maple. C.
Lenzites flaccida (Bull.) Fr. var. *variegata* (Fr.) Cost. and Dufour (Rea. Brit. Basid. 613. 1922).—*L. variegata* Fr. (Bourdot and Galzin, Nym. d. Fr. 580. 1927).—*L. betulina forma variegata* (Fr.) Lloyd.
This seems to be the common form in the United States. The pilei are thin and have broad bands of orange between wood colored zones. Spores elliptical, some curved, hyaline, smooth, 4–6.5 x 2–4 μ.
Polyporus adustus (Willd.) Fr.—*Bjerkandera adusta* (Willd.) Karst. I.
Polyporus biformis (Klotzsch.) Berk.—*Coriolus biformis* (Klotzsch.) Pat.
Spores 4–7 x 2 μ, curved, hyaline, hyphae 4 μ, on beech. C.
Polyporus brumalis (Pers.) Fries.—*Polyporus polyporus* (Retz.) Murr. S.
Polyporus caesius (Schrad.) Fr.—*Tyromyces caesius* (Schrad.) Murr.
Spores 4–5 x 1–2 μ, curved, smooth. I.
Fomes connatus (Weinm.) Gill—*Fomes populinus* (Schum.) Cooke.
Spores 3–5 μ, globose, hyaline, on maple. S.
Polyporus delectans Peck.—*Spongipellis delectans* (Pk.) Murr. S.
Polyporus galactinus Berk.—*Spongipellis galactinus* (Berk.) Pat. S.
Polyporus gilvus (Schw.) Fries—*Hapalopilus gilvus* (Schw.) Murr. C.
Polyporus hirsutus (Wulf.) Fries—*Coriolus nigromarginatus* (Schw.) Murr. C.
Polyporus pargamenus Fr.—*Coriolus prolificans* (Fr.) Murr.
Spores 6–8 x 2–4 μ, smooth, hyaline, curved, on beech. C.
Spores 6–8 x 2–3 μ, smooth, curved, on black cherry. C.
Polyporus rigidus Lév. (resupinate form).
Spores 3–4 x 2–3 μ, hyaline. S.
Polyporus sulphureus (Bull.) Fr.—*Laetiporus speciosus* (Batt.) Murr.
Spores 6–8 x 5–6 μ, hyaline, on chestnut. S.
Polyporus tephroleucus Fr.—*Polyporus albellus* Am. Auth., not Peck.
Spores 4–5 x 1–1.5 μ, smooth. Hyphae of context 4 μ diam., unbranched. Clamps present. I.
Polyporus tulipiferus (Schw.) Overholts.—*Irpiciporus lacteus* (Fr.) Murr.
Spores 5–7 x 2 μ, curved, hyaline, smooth, on beech. C.
Polyporus versicolor (L.) Fr.—*Coriolus versicolor* (L.) Quel. C.
Poria eupora Karst. S.
Trametes Sepium Berk.—*Coriollelus Sepium* (Berk.) Murr. I.
Phlebia radiata Fr. C.
Geaster Triplex Jung. S.
Lycoperdon gemmatum Batsch.
Spores spiny, spherical, 4–5.5 μ.; capillitium thread brown, 6μ, little if any branching, ends obtuse. C.

Lycoperdon pyriforme Schaeff.
Spores brown, spherical, 3.7–4 μ, with large oil drop; capillitium threads 3.6–4.5 μ, ends blunt, branched occasionally, pale olivaceous. C.
Lycoperdon umbrium Pers.
Spores spherical, 3.5–4 μ, smooth, with oil drop; capillitium threads 4–5 μ, ends blunt. I.
Scleroderma aurantium (Vaill.) Pers.—*Scleroderma vulgae* (Hornem.) Fr.
Spores spiny, 10–12 μ, dark brown, spherical; hyphae light brown, 6–8 μ, with tapering ends. C.

II. Geauga County, Bainbridge Township, Bingham Farm Collections.—Thirty-two species are reported.

Exidia glandulosa Fr. C.
Guepinia spathularia (Schw.) Fr., on *Prunus serotina*. S.
(See G. W. Martin, Am. Jour. Bot. 23: 627–629, 1936, for validity of this name.)
Schizophyllum commune Fr. Common on *Carpinus* and *Malus*.
Coniophora arida (Fr.) Karst.
Spores 8.8–11 x 6.8 μ. On *Carpinus*.
Peniophora cinerea (Pers.) Cooke. On *Carpinus* and *Quercus alba*. C.
Stereum sericeum Schw. On *Carpinus*. C.
Corticium investiens (Schw.) Bres. C.
Odontia crustosa (Pers.) Quel. On *Carpinus*.
Merulius ceracellus Berk. and Curt. On *Malus*. S.
Phlebia radiata Fr. On *Malus* and *Prunus serotina*. I.
Daedalea confragosa (Bolt.) Fr. On Black Cherry. C.
Lenzites trabea (Pers.) Fr. (Overholts, Bull. Penn. State Coll. 316:5, 1935).
Lenzites vialis Peck.—*Gloephyllum trabeum* (Pers.) Murr. Lamelloid form. On *Prunus serotina*.
Polyporus biformis (Klotzsch.) Berk.—*Coriolus biformis* (Klotzsch.) Pat. C.
Polyporus brumalis (Pers.) Fr.—*Polyporus polyporus* (Retz.) Murr. On *Prunus serotina*. S.
Polyporus albellus Peck.—*Polyporus chioneus* Am. Auth. not Fries. On *Prunus serotina*.
Polyporus caesius (Schrad.) Fr.—*Tryomyces caesius* (Schrad.) Murr. On *Tilia* and *Ulmus americana*. I.
Polyporus fumosus (Pers.) Fr.—*Bjerkandera fumosa* (Pers.) P. Karst.
Spores smooth, hyaline, ellipsoid-ovoid, 2–3 x 4.5–6 μ. I. On *Ulmus ameri.*
Polyporus hirsutulus Schw.—*Coriolus hirsutulus* (Schw.) Murr. On *Acer and Fraxinus*.
Polyporus hirsutus Fr.—*Coriolus nigromarginatus* (Schw.) Murr. On *Amelanchier canadensis*.
Polyporus psrgamenus Fr.—*Coriolus prolificans* (Fr.) Murr. On *Prunus serotina*.
Polyporus picipes Fr. On *Ulmus americana*. S.
Polyporus pubescens (Schum.) Fr.—*Coriolus pubescens* (Schum.) Murr. On *Prunus seratina*. S.

Polyporus tulipiferus (Schw.) Overholts—*Irpiciporus lacteus* (Fr.) Murr. On *Quercus alba* and *Prunus seratina.*

Polyporus versicolor (L.) Fr.—*Coriolus versicolor* (L.) Quel. On *Prunus seratina and Platanus occidentalis.* C.

Poria candidissima (Schw.) Cooke. Det. L. O. Overholts.

This *Poria* seems to be a rare species. In his study of *Porias* in 1923, Overholts was able to examine only six specimens from this country. Two characteristics are unique: the spores are echinulate, and the hyphae have occasional swollen walls next to the cross walls. Spores 2.5–4 μ. On beech.

Poria corticola Fr. Det. L. O. Overholts.

Poria eupora (P. Karst.) Cooke. On *Acer.*

Poria ferruginosa (Schrad.) Bres. On *Carpinus.*

Poria medulla-panis (Pers.) Cooke. On *Castanea.*

Poria versipora (Pers.) Fr. On *Carpinus.*

Polyporus conchifer (Schw.) Fr.—*Poronidulus conchifer* (Schw.) Murr. On *Ulmus americana.*

Fomes fulvus (Scop.) Gill—*Pyropolyporus fulvus* (Scop.) Murr. On *Prunus.*

Spores 3–5 x 4–6 μ.

THE RATE OF GROWTH OF FINGER NAILS IN RELATION TO THEIR CYSTINE CONTENT IN ARTHRITICS

LINDEN F. EDWARDS
Department of Anatomy, The Ohio State University

INTRODUCTION

Several investigators, notably Berthold (1), Dufour (2), Sharpey-Schafer (3), Heller (4) and Voit (5), employing different methods of measurement, have reported that finger nails grow on the average of 1 mm. in ten days, that is, one-tenth of a millimeter (0.100 mm.) per diem. Results obtained by the writer on the growth of finger nails of a large number of apparently normal, healthy individuals agree in general with this rate. As to the factors upon which nail growth depends numerous ones have been suggested. Thus Berthold found that nails grow more rapidly in summer than in winter, in children than in adults, on the right than on the left hand and that the rate of different finger nails differs according to the length of the finger, the most rapid being on the middle then in order the ring, index and little finger and slowest on the thumb.

Moreover, it is well known among clinicians that nails exhibit a hypersensitiveness to disease, especially the acute infectious type as, for example, smallpox, rheumatic, typhoid and scarlet fever. The writer is now engaged in a study of the effect of various diseases and other nutritional disturbances, such as pregnancy, hyperthyroidism and hypothyroidism, on the rate of growth of the nails. Concomitant with this study has arisen the question concerning the relation of the growth of finger nails to their cystine content.

Much interest in recent years has been attached to the physiologico-chemical significance, dietary importance and therapeutic value of cystine. The chemistry of cystine need not be dwelt upon here other than to remark that it is a sulfur compound which forms the basic constituent of keratin, a substance composing such epidermal derivatives as hair, nails, hoofs, horns, feathers, et cetera. As to the physiological significance of cystine, various workers, notably Hopkins and Dixon (6), Lewis (7), Lewis and Root (8), have pointed out that sulfur compounds play an important part in the metabolic processes of cells, especially oxidation and reduction. Accord-

ing to Sullivan and Hess (9) intoxication factors such as bacteria and toxins tend to deplete these regulators of metabolism and thus divert them from their normal reservoirs such as nails. They analyzed the finger nail clippings of 26 normal individuals and 103 arthritics and found that the average cystine content of the nails of the normals was 11.69%, whereas the average for the arthritics was 9.77%. They conclude, therefore, that this decreased cystine content of the nails of arthritics is an index of a toxic factor.

In the light of these and other researches it is now believed by many workers that, notwithstanding the possibility of numerous etiological agents or predisposing causes, the prime factor in arthritis and allied rheumatoid conditions is diminished oxidation resulting from impaired sulfur metabolism—hence the rationale for parenteral sulfur therapy, many favorable results of which have been reported in recent years.

In addition to the reports bearing on the chemotherapeutic action of cystine significant studies have been reported in the last few years concerning the relation between dietary cystine and the growth, texture and cystine content of animal hair and wool. Although the results reported are not unanimous, most of the evidence presented indicates that the growth and histological structure of these epidermal derivatives depend largely on the presence or absence of cystine in the diet.

As a result of these various researches concerning the importance of cystine it seemed logical in connection with the writer's study of the effect of disease on the growth of nails to determine whether or not there is any marked relationship between the growth of the nails and their cystine content. The object of this paper, therefore, is to report the results of a study based on thirty-five arthritic patients who were under observation and treatment at the Arthritic Clinic of the State Street Dispensary, College of Medicine, Ohio State University.

METHODS

The method employed for determining the daily rate of growth of the finger nails was as follows: A mark was made on each nail at the central convex line of the lunula, when present, by means of a sharp, curved scalpel. The daily rate of growth was ascertained by dividing the distance which the mark traversed from the anterior margin of the lunula by the number

of days elapsing from the date of marking to the date of measuring. Thus let us suppose the distance of the mark from the lunula in 30 days was 3.2 mm. The daily rate of growth would be (3.2 mm. divided by 30 days) 0.106 mm. The nails on which a lunula could not be observed were marked at a determined distance, usually five millimeters, proximal to the anterior central border of the nail bed which is visible through the nail. The distance which the nail grew in these cases was calculated by subtracting the distance between the mark and the anterior border of the nail bed from the distance between the latter point and the mark used as a measuring point. Hence if the mark was placed at a point 5 mm. from the anterior border of the nail bed and 30 days later it was 2.8 mm. from the latter the amount of growth would be (5 mm. minus 2.8 mm.) 3.2 mm. The daily rate of growth, calculated the same as above, would be (3.2 mm. divided by 30 days) 0.106 mm.

All measurements were made by means of a Vernier caliper calibrated in millimeters. In order to insure a fine degree of accuracy the two measuring arms of the Vernier were sharpened and the marks on the nails, as well as the adjustments of the measuring arms of the Vernier to these marks, were made under magnification with the use of a binocular loupé.

The cystine content of the finger nails was determined by Miss Edith M. Miller, Department of Pathology, Ohio State University, who utilized Sullivan's method with a few modifications. The writer wishes to acknowledge his indebtedness to Miss Miller for furnishing the data on the cystine content of the finger nail clippings and to Dr. Geo. E. Watson, director of the Arthritic Clinic, for permission to use the clinical patients for this study.

In Table I are tabulated the results of the present study on the rate of growth of finger nails of arthritic patients in relation to their cystine content.

The rates of growth tabulated here represent the mean daily rate of growth of all the finger nails of each subject and is expressed in thousandths of a millimeter. Thus, for example, in subject G. A. the mean rate of growth of all his finger nails is .110 mms. daily. The cystine content of the nails of each subject is shown in the last column of the table and is expressed in percentage. At the bottom of the table are given the mean age of the group, the mean daily rate of growth and the mean cystine content of the nails of all the subjects.

Although it is not the object of this paper to make a comparative study of the daily rate of growth or cystine content of the finger nails of arthritic patients with normal individuals, it

TABLE I

DAILY RATE OF GROWTH OF FINGER NAILS CORRELATED WITH CYSTINE CONTENT
(35 subjects)

SUBJECT	AGE	SEX	MEAN GROWTH	CYSTINE %
G. A	50	M	110	12 0
C B	25	M	118	11 6
G C	59	M	091	12 2
W. C	52	M	071	10 5
L. C	30	M	123	8 7
I. E	69	F	097	14 5
A. E	51	F	106	14 2
W. F.	62	M	128	12 5
J. F	53	M	080	6 8
E. F	65	M	068	12 5
L. G	56	F	114	12 5
F. G	45	M	095	11 5
A G	34	F	106	17 6
R. H	65	F	111	9 2
W. H	50	M	104	9 7
M. K	74	M	085	10 1
C. K	48	M	091	9 7
H. K	20	F	094	11 5
M. L	58	F	112	10 2
G. M	22	M	107	14 1
R. M	49	M	059	13 0
A. M	63	F	091	8 3
E. M	35	F	131	14 6
F. M	54	M	085	12.3
B. M	44	M	107	10 6
O. N	31	M	103	11 3
A. N	35	F	101	12 0
S. O	45	M	093	10 2
M. S	51	F	089	11.1
F. S	67	F	122	9 1
H. S	51	F	081	11 4
M S	68	F	107	10 8
W. T.	27	M	102	16 5
E. T	39	M	072	12 6
M. V	39	M	122	11 3
Mean	48 1		099	11.6

can be observed from the results recorded in the table that in the case of the 35 arthritic patients studied the mean daily rate of growth is 0.099 mm. which is essentially similar to normal, being only 0.001 mm. below one-tenth of a millimeter, the accepted normal rate. According to Sullivan and Hess (9)

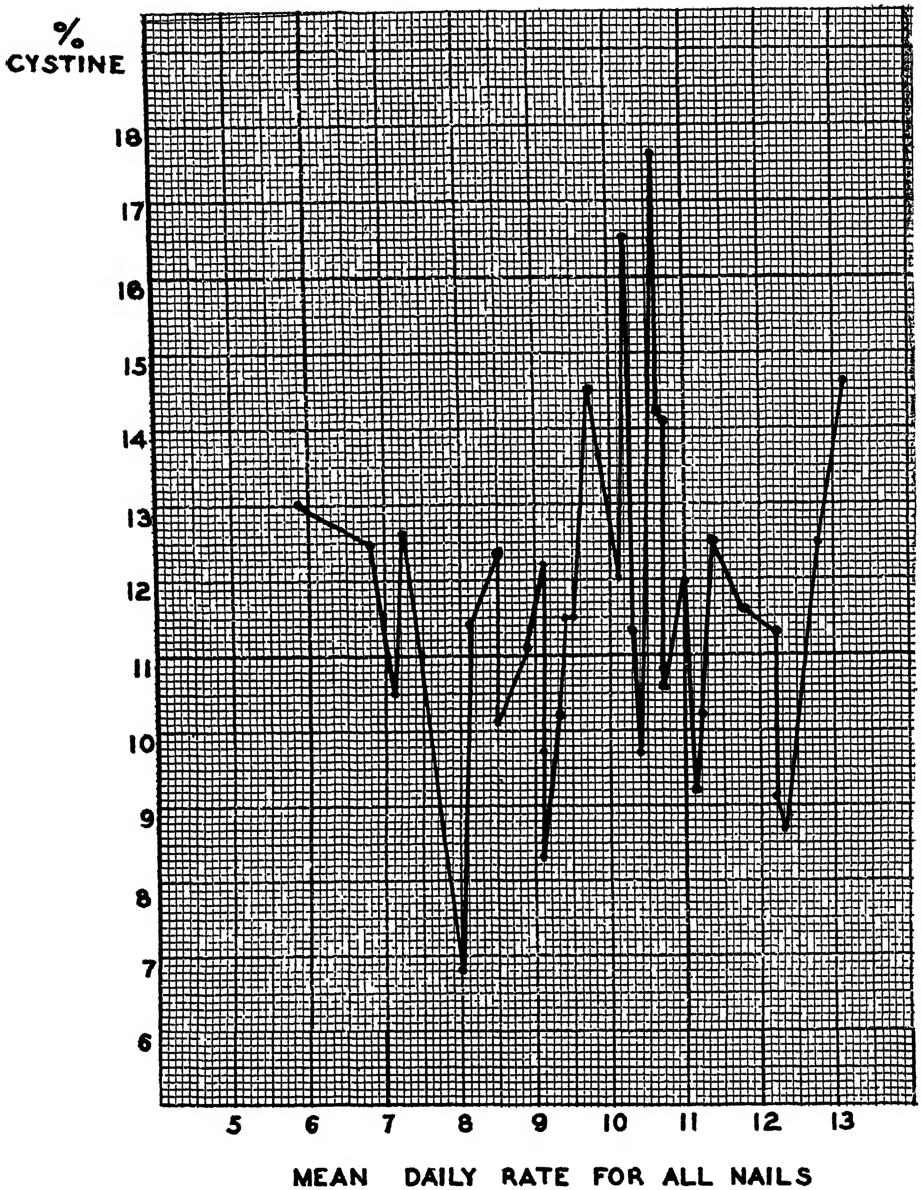


Fig. 1. The mean daily rate of growth of the finger nails in relation to their cystine content.

the average normal cystine content of finger nails is roughly 12% as compared with arthritics in which it is in general lower. As is shown in the table the mean percentage of cystine contained in the finger nails of the 35 patients examined is 11.6% which is only four-tenths percent (0.4%) below the accepted normal.

In regard to the question as to whether or not there is any correlation between the rate of growth of finger nails and their cystine content in arthritics it is logical to conclude from the results shown in Table I and graphically represented in Figure 1 that no such correlation exists. Take for example the cases in which the cystine content of the finger nails ranges from 12% to 12.5%, the rates of finger nail growth vary much more considerably, thus 068 (E. F.), 085 (F. M.), 091 (G. C.), 101 (A. N.), 110 (G. A.), 114 (L. G.), and 128 (W. F.) thousandths of a millimeter. Similarly if we compare the five lowest rates of nail growth, namely, 059 (R. M.), 068 (E. F.), 071 (W. C.), 072 (E. T.) and 081 (H. S.), with their respective cystine content the range of variation of the latter is likewise quite considerable, thus 13, 12.5, 10.5, 12.6 and 11.4 percenta. Neither is the highest mean daily rate of nail growth (131 thousandths of a millimeter) correlated with the highest cystine content (17.6%) or the lowest rate (.059 mm.) with the lowest cystine content (6.8%) or vice versa. Moreover, it is evident that should a correlation exist between these two factors we should expect to have either a gradual ascending or a descending curve, depending of course upon whether a high cystine content corresponds to a high rate of growth, which we should expect, or to a low rate.

SUMMARY AND CONCLUSIONS

1. The problem as to whether the daily rate of growth of finger nails of arthritics is correlated with their cystine content was undertaken in view of other researches concerning (1) the importance of sulfur compounds, such as cystine, to the metabolic processes of cells; (2) the significance and relation of cystine of the nails to toxicity and disease, such as arthritis; (3) the beneficial effects of dietary cystine on the growth of animal hair and wool.

2. The amount of growth of the finger nails of 35 arthritic patients used in this study was determined by measuring the distance which a mark, previously made, grew from the convex

central line of the lunula of the nail or toward the anterior border of the nail bed in a given length of time by means of a Vernier caliper calibrated in millimeters.

3. The daily rate of finger nail growth was calculated by dividing the amount of growth by the number of days of growth. Only the mean daily rate of all the nails of each patient was recorded. Considerable variation in daily rates of finger nail growth existed between patients. The mean finger nail rate of the 35 patients was 0.099 mm. daily, which may be taken as normal, since this figure does not differ significantly from the accepted normal rate, that is 0.100 mm.

4. The cystine content of the nail clippings of these patients likewise varied considerably, the mean percentage being 11.6, which is slightly below the normal (12%).

5. There is no evidence in the present study of any correlation between the daily rate of finger nail growth and the cystine content of the nails in arthritics.

REFERENCES

(1) **Berthold, A. A.** Beobachtungen uber das quantitative Verhaltniss der Nagel- und Haarbildung beim Menschen, Verhandl. d. Göttingen gelehrten Gesellsch, 1850.

(2) **Dufour, M. L.** Observations sur la Vitesse d'accroissement des Ongles, Bulletin de la Societe Vandoise des Sciences Naturelles, 11, 195, 1872.

(3) **Sharpey-Schäfer, E.** Observations on the relative rate of growth of the nails of the right and left hands respectively: On seasonal variations in the rate, and on the influence of nerve-section upon it. Proc. of the Royal Soc. of Edinburgh, 51, 8, 1930.

(4) **Heller, J.** Die Krankheiten der Nagel, Berlin, 1900.

(5) **Voit, E.** Über die Grösse der Erneverung der Horngebilde beim Menschen, Zeitschrift fur Biologie, 90, 509, 1930.

(6) **Hopkins, F. G. and Dixon, M.** On Glutathione. II. A thermostable oxidation-reduction system. Jour. Biol. Chem., 54, 527, 1922.

(7) **Lewis, H. B.** The Metabolism of Sulfur. Jour. Biol. Chem., 42, 289, 1920.

(8) **Lewis, H. B. and Root, L. E.** Ibid., 50, 303, 1922.

(9) **Sullivan, M. H. and Hess, W. C.** The cystine content of the finger nails in arthritis. The Jour. of Bone and Joint Surgery, 16, 185, 1934.

THE MORPHOLOGY OF THE ALIMENTARY TRACT OF THE BLISTER BEETLE, EPICAUTA PENNSYLVANICA, DEG. (COLEOPTERA: MELOIDAE)

HERMAN E. MATTINGLY
Columbus, Ohio

INTRODUCTION

In central Ohio the black blister beetle, *Epicauta pennsylvanica*, Deg., is found in abundance in September feeding on the pollen of goldenrod (Solidago). This member of the Meloidae is wholly black, ranging in length from 7 to 13 mm.

METHODS

Specimens collected were placed in Kahle's fixative immediately after being killed with potassium cyanide. Twenty-four hours later they were transferred to seventy per cent alcohol. Borax-carmine was used as an *in toto* stain before embedding in paraffin. Serial sections were stained in haemalum (one part to two parts alcohol) for seventeen minutes, and in Fast Green for thirty seconds. Difficulty was experienced in getting good sections of large structures. This was thought to be due to the hardening effect of the higher alcohols. A Dioxan technique was tried, hoping to toughen the material and make it more elastic. This method, however, removed the *in toto* stain and was abandoned.

ACKNOWLEDGMENTS

The author is grateful for the criticisms and advice of Dr. C. H. Kennedy, who supervised the work, and whose "Methods for the Study of the Internal Anatomy of Insects" was used as a manual of technique. Many valuable suggestions were also given by Dr. P. E. Schaefer.

THE GROSS ANATOMY

The morphology of the alimentary tract (Plate I, Fig. 1) of *E. pennsylvanica* Deg., is relatively simple. It has three main divisions: The fore-intestine (stomadaeum), the mid-intestine (mesenteron), and the hind-intestine (proctodaeum). Of these the stomodaeum and the proctodaeum are of ectodermal origin since they are formed by anterior and posterior invaginations respectively of the external germ layer. The mesenteron originates from the endoderm.

The fore-intestine is straight and simply constructed. It extends through the thorax and first abdominal segment. The mid-intestine is much larger in diameter and occupies the greater part of the abdominal cavity. It extends from the anterior of the first to the middle of the seventh abdominal segment. The hind-intestine is about one-half the diameter of, and approximately one and one-third times the length of the mid-gut.

The Fore-Intestine

There is no distinct pharynx, oesophagus, and proventriculus in the fore-intestine. The oesophagus is narrow anteriorly, gradually increasing in diameter until it empties into the mid-gut. The comparative size of the anterior, middle and posterior regions of the oesophagus may be noted in Plate II, Figures 1, 2 and 3. The gradual enlargement of the oesophagus is the only semblance of a proventriculus or gizzard. A lack of a definite chamber of mastication is typical of pollen feeding insects. The fore-intestine extends into the mid-intestine forming a pronounced oesophageal valve (Plate III, Fig. 5). There is no external indication of this valve.

The Mid-Intestine

The mid-intestine is larger in diameter than any other part of the alimentary tract, tapering at either end where it joins the fore-intestine and hind-intestine respectively. Externally the mid-gut appears folded or wrinkled transversely. This wrinkled appearance is due to the infolding of the thickened epithelial tissue.

The Hind-Intestine

There are three definitely differentiated regions forming the hind-intestine. These regions are the ileum, the colon, and the rectum. Just posterior to the mesenteron the ileum bends forward dorsally, extending anteriorly about one-half the length of the mid-intestine. The colon begins at the posterior bend of the ileum in its position over the mesenteron. The colon enlarges toward the rectum, where it constricts abruptly. This constriction is more pronounced dorsally. The rectum is about two-thirds the diameter of the colon at their point of union. Anterior to the anal opening the rectum enlarges slightly.

Malpighian Tubules

Six Malpighian tubules enter the alimentary tract at the point where the mid-intestine and hind-intestine meet. These tubules make many convolutions throughout the body cavity of the beetle, eventually entering under the connective tissue which covers the colon. The exact point at which the tubules enter under this tissue was not determined definitely, but it is in the bend of the hind-intestine where the ileum and colon meet. The tubules are found in numerous short bendings along the entire length of the colon, ending abruptly at the rectal constriction.

THE HISTOLOGY OF THE ALIMENTARY TRACT

The Fore-Intestine

Just as there is no morphological differentiation of the fore-intestine, so also there is no histological separation into a pharynx, oesophagus, and proventriculus. The wall of the fore-intestine is made up of the following five regions listed successively from interior to exterior: (1) a chitinous inner lining, or intima; (2) a thin epithelium; (3) longitudinal muscles; (4) circular muscles; and (5) a membrane of connective tissue covering the whole fore-intestine.

The intima is apparently composed of two layers. This is evident from the fact that a definite inner part of it stains much deeper with Fast Green than does the outer part. Within this intima there are six or seven deep longitudinal infoldings which extend the entire length of the fore-intestine. The folds increase in size toward the mesenteron, and as many as three or four smaller infoldings may occur between the larger ones at the region where the fore-intestine and mid-gut meet (Plate II, Fig. 4). The intima is modified on the interior surface and assumes a serrate appearance. In some specimens these serrations were further modified forming definite spines.

The epithelium of the fore-intestine is a single layer of elongated and flattened cells. This tissue follows the outer surface and the infoldings of the intima.

Although the longitudinal muscles occur around the entire circumference of the stomodaeal wall, they are massed for the most part at the base of, and in the infoldings of the intima and epithelium.

The next outer histological region of the fore-intestine is composed of circular muscles, which vary in the number of layers from one to three.

As the oesophagus enlarges posteriorly the wall becomes thinner. The longitudinal muscles are fewer, and the circular muscles limited in number.

There is no external indication of an oesophageal valve. It can, however, be readily demonstrated by pulling the oesophagus forward from the mesenteron. This action will pull from within the mesenteron an extension of the oesophagus. This extension of the oesophagus into, and for a distance of one-third the length of the mesenteron, is the oesophageal valve (Plate III, Fig. 5). Just at the point of entry of the oesophagus into the mid-gut, gross dissection reveals six splinter-like fingers of chitin. These chitinous structures are light brown in color, and run along the longitudinal axis of the alimentary tract almost to the end of the extension of the oesophagus into the mesenteron. A microscopical examination of a cross section shows these chitinous fingers to be located on the interior surface of the intima (Plate III, Fig. 6). These pieces of chitin remain unstained in mounted serial sections, and are not united at any point but are attached to, or embedded in, the layer of intima. R. T. Everly, in his study of the Margined Blister Beetle, found only four such structures. He also found that they were attached anteriorly only and were free and separate posteriorly.

The inner surface of the intima of the oesophageal valve of the Margined Blister Beetle, according to Everly, is definitely more modified than the anterior oesophagus. He found the same true of the pyloric valve region. No such definite differentiation is to be found between the anterior intima of the oesophagus of *E. pennsylvanica* and the intima of the oesophageal valve, or between the intima of the pyloric valve and that of the remainder of the hind-intestine.

In the region where the oesophagus and mesenteron unite fatty tissue is part of the wall of the alimentary tract. Circular muscles surround the valve under and posterior to this fatty tissue. There is a definite ring of these muscles which probably act in constricting and closing the alimentary passage. The epithelium of the oesophagus is continuous, extending into the valve well towards the end of the extension. This epithelium also is continuous anteriorly from this point around the outside of the ring of circular muscles, eventually uniting with the anterior epithelium of the mesenteron. Before it unites with the mesenteric epithelium, the epithelium of the oesophageal valve evaginates into the crypt of the first fold of the mid-gut epithelium. This forms a collar-like structure of intima and epithelium around the oesophageal extension.

The Mid-Intestine

The mid-gut is composed of epithelium, a basement membrane, circular muscles, and longitudinal muscles. There is also a peritrophic membrane. There is, however, no cuticula in the mid-intestine. This division of the alimentary tract has a thick wall due to (1) the gradual transition of the epithelium from the flat cells of the oesophagus to the columnar type of the mid-intestine, and (2) to the infoldings of this epithelial tissue. Circular muscles are well developed throughout the length of the mid-gut, but longitudinal muscles are very few.

It is probable that the ring of epithelial cells surrounding the oesophageal valve does not secrete the peritrophic membrane, since it has an inner cuticular covering which is continuous with that of the oesophagus. Whether the epithelial lining of the mid-intestine secretes the peritrophic membrane has not been determined.

The type of secretion is probably holocrine, i. e., it is due to the destruction of cells of the inner epithelium (Plate IV, Fig. 7). On the inner surface of the epithelium there is no striated border, but there are numerous globules of secreted fluid "budding" off from the ends of the cells. In some cases it appears that the whole end of the cell is breaking away. Ends of some cells also seem to have transparent vacuoles.

New cells are formed in round outward extensions of the epithelium. Some of these extensions break through the basement membrane and constrict at the outer surface to form round cellular aggregations. Some of these epithelial masses lie in the muscles, detached from the inner epithelial layer. At intervals the inner epithelial layer itself extends through to the outer surface, forming papillae there. The separate masses may be regenerative cells, as also may be the papillae-like extensions. Their function could not be demonstrated.

The Hind-Intestine

The mid-gut tapers off somewhat abruptly to form the ileum. The six Malpighian tubules enter in this region. A longitudinal histological examination of this region of union between the mesenteron and hind-intestine shows that the pyloric valve is relatively simple—if it can be called a valve (Plate IV, Fig. 7). This examination also shows that the Malpighian tubules enter the alimentary tract just at the posterior extremity of the mesenteric epithelium, and anterior to the tongue-like projection of the cuticular covered epithelium of the ileum. Everly found in his study of the Margined Blister Beetle, that the Malpighian tubules entered just posterior to this intima-covered invagination of the epithelium. The intima of this epithelium is relatively thick. The wall of the ileum just posterior to the entry of the Malpighian tubules contains an abundance of circular muscles from three to five layers deep.

Posteriorly the ileum has a thin wall (Plate V, Fig. 12). The intima, as in the region of the oesophageal valve, does not have spines or tooth-like projections which were found in the Margined Blister Beetle by Everly. In *E. pennsylvanica* the intima of the ileum is relatively smooth. The epithelium consists of a single layer of short cuboidal cells. There is a single layer of circular muscle cells, but longitudinal muscle cells are few.

At the bend over the mesenteron where the hind-intestine turns laterally and posteriorly, the ileum and colon meet. In this bend there is an increase in the number of layers of circular muscles. Longitudinal muscles are present in this region definitely grouped around the circumference of the outer layer of circular muscles.

The colon extends from the above described bend of the hind-intestine to the rectum. The wall of the anterior colon is thick (Plate V, Fig. 10). It has large infoldings of intima which are filled with epithelium. Surrounding the epithelium are the circular muscles, four and five layers deep. These muscles are arranged in six symmetrical groups or bundles, and have the appearance of being "tied in" at six equidistant points by groups of several longitudinal muscles.

The colon enlarges gradually toward the rectum, the wall becoming thinner. At the posterior end the colon is about one and one-third times the diameter of the rectum, and about one-half the diameter of the mid-gut (Plate V, Fig. 13). The colon is constricted abruptly in the seventh abdominal segment to form the rectum.

The anterior rectum has from 10 to 12 cuticular invaginations filled with epithelium (Plate V, Fig. 11), which nearly fill the lumen of the rectum. The wall is quite thick, made up almost entirely of circular muscles, only a few scattered longitudinal muscles being present. The rectum enlarges slightly toward the anal opening. In general, the rectum is wrinkled in appearance, although this is somewhat obscured in gross dissection by the connective membrane which covers the colon and rectum.

The Malpighian Tubules

The Malpighian tubules, six in number, enter the gut at the anterior end of the hind-intestine. At the point of entry they are covered with

a broad ring of circular muscles (Plate IV, Fig. 8). There is also a definite covering of connective membrane evident in longitudinal and cross sections of the Malpighian tubules.

There are two semi-circular folds in the wall of the hind-intestine between the openings of each of the tubules (Plate IV, Fig. 9). There is no external indication of this; however, there is a clearing and smoothing of the region between the points of entry of the tubules, due to the absence of papillae. The opening of the Malpighian tubules into the lumen is surrounded by a ring of columnar epithelial cells (Plate IV, Fig. 8).

After many bendings throughout the body cavity the tubules enter under the connective tissue which covers the colon. They occur all along the colon under this membrane and end abruptly at the point where the colon constricts to the size of the rectum (Plate V, Fig. 13).

SUMMARY

In general, the morphology of *E. pennsylvanica* is like that of the Margined Blister Beetle as determined by R. T. Everly. There is little or no differentiation of the fore-intestine, except for a well-developed oesophageal valve. This valve has six finger-like pieces of chitin on its inner surface as it extends into the mesenteron. In this it differs from the Margined Blister Beetle which, according to Everly, has just four such chitinous "fingers."

Secretion is holocrine. There are evaginations of the mesenteric epithelium through the circular muscles to the surface of the mesenteron, forming papillae which are visible externally.

The Malpighian tubules, six in number, empty into the hind-intestine just at the point of union with the mid-gut, and not posterior to the poorly developed pyloric valve as was found in the Margined Blister Beetle by Everly. These tubules, after convolutions through the body cavity, enter under the connective membrane of the colon, where, with many short bendings, they extend to the rectal constriction of the colon. No connection with the lumen of the intestine in the region of the posterior colon could be demonstrated.

The ileum is somewhat muscular anteriorly, but the greater part is a thin wall of intima, epithelium, circular muscles, and a few longitudinal muscles.

The anterior colon has a well-developed muscular system. The circular muscles are "tied in" at six equidistant points by bundles of longitudinal muscles.

The rectum is quite muscular. The rectal lumen is well filled with invaginations of intima.

BIBLIOGRAPHY

Auten, Mary. The Structure of the Digestive System in *Bolitotherus cornutus*. Ohio Journ. Sci., Vol. XXXIII, No. 4, 1933.

Becton, Jr., Edward Major. The Alimentary Tract of *Phanaeus vindex* Macl. (Scarabaeidae). Ohio Journ. Sci., Vol. XXX, No. 5, 1930.

Bess, Henry A. The Alimentary Canal of *Calasoma syncophanta* Linnaeus. Ohio Journ. Sci., Vol. XXXV, No. 1, 1935

Bigham, John T. The Alimentary Canal of *Asaphes memnonius* Hbst. . Ohio Journ. Sci., Vol. XXXI, No. 5, 1931.

Blood, Rosella. The Anatomy of *Pyrota mylabrina* (Chev). Journ. of Ent Soc. of New York, Vol. XLIII, No. 1, 1935.

Breakey, E. P. Histological Studies of the Digestive System of the Squash Bug, *Anasa tristis* Deg., (Hemiptera, Coreidae).

Brubaker, Ross W. The Alimentary Tract of *Penthe pimelia* Fabr. (Coleoptera: Dacnidae). Ohio Journ. Sci., Vol. XXIV, No. 1, 1937.

Burgess, Emory D. A Comparison of the Alimentary Canals of the Active and Hibernating Adults of the Mexican Bean Beetle, *Epilachna corrupta* Muls. Ohio Journ. Sci., Vol. XXXII, No 3, 1932.

Cecil, Rodney. The Alimentary Canal of *Philaenus leucophthalmus* L. Ohio Journ. Sci , Vol. XXX, No. 2, 1930.

Comstock, J. H. An Introduction to Entomology. Comstock Publishing Co., Ithaca, N. Y., 1930.

Davidson, R. Howard. The Alimentary Canal of *Crioceris asparagi* Linn. Ohio Journ. Sci., Vol. XXXI, No. 5, 1931.

Dean, R. W. The Alimentary Canal of the Apple Maggot. Ann. Ent Soc. Am., Vol. XXV, No. 1, 1932.

Dean, R. W. Morphology of the Digestive Tract of the Apple Maggot Fly, *Rhagoletis promonella* Walsh. Bull N. Y. State Agr. Exp. Sta., Tech. Bull. No 215, 1933.

Everly, Ray Thomas. The Alimentary Tract of the Margined Blister Beetle, *Epicauta cinera marginata* Fab (Coleoptera: Meloidae). Ohio Journ. Sci., Vol. XXVI, No. 4, 1936

Fletcher, Fred Walker. The Alimentary Canal of *Phyllophaga gracilis* Burm. Ohio Journ. Sci., Vol. XXX, No. 2, 1930.

Hammer, A. L. The Gross Anatomy of the Alimentary Canal of *Solubea pugnax* (Fab.). (Heteroptera: Pentatomidae). Ohio Journ. Sci., Vol. XXVI, No. 3, 1936

Hood, Charles W. The Anatomy of the Digestive System of *Oncopeltus fasciatus* Dall. (Heteroptera: Lygaeidae). Ohio Journ. Sci., Vol. XXXVII, No. 3, 1937.

Hough, W. S. The Internal Anatomy of the Clover Root Mealy-Bug, *Trionymus trifolii*, Forges (Homoptera: Coccidae). Bull. of Ent. Res., Vol. 16, Pt. 1, 1935.

Imms, A. D. A General Textbook of Entomology. E. P. Dutton & Co., Inc., New York, 1929.

Jahn, Lydia A. The Internal Anatomy of the Mydas Fly. Ohio Journ. Sci., Vol. XXX, No. 2, 1930.

Kennedy, C. H. Methods for the Study of the Internal Anatomy of Insects. H. L. Hedrick, Columbus, Ohio, 1932.

Knowlton, George F. The Digestive Tract of *Longistigma caryae* (Harris). Ohio Journ. Sci., Vol. XXV, No. 5, 1925.

Landis, Birely J. Alimentary Canal and Malpighian Tubules of *Ceratomegilla fuscilabris* Muls. Annals Ent. Soc. Am., Vol. XXIX, No 1, March, 1936

Lewis, Harold C. The Alimentary Canal of *Passalus*. Ohio Journ. Sci., Vol. XXVI, No. 1, 1926.

Miller, Warren C. The Alimentary Canal of *Meracantha contracta* Beauv. (Tenebrionidae). Ohio Journ. Sci., Vol. XXI, No. 3, 1931.

Neiswander, F. B. The Alimentary Canal of *Harpalus pennsylvanicus* Dej. (Carabidae: Coleoptera). Ohio Journ. Sci., Vol. XXXV, No. 6, 1935.

Potts, Samuel F. The Alimentary Canal of the Mexican Bean Beetle. Ohio Journ. Sci., Vol XXVII, No. 3, 1937. 27

Schaefer, Paul E. The Alimentary Canal of *Sphaeroderus nitidicollis* Chev. Var. Schaumi Chd. (Coleoptera). Ohio Journ. Sci., Vol. XXXI, No 5, 1931.

Snodgrass, R. E. Principles of Insect Morphology. McGraw-Hill Book Co., New York, 1935.

Stuart, Richard R. The Anatomy and Histology of the Malpighian Tubules and the Adjacent Alimentary Canal in *Melanoplus differentialis*. Journ. Morph. 58 (1), 173–188.

Swingle, Millard C. Anatomy and Physiology of the Digestive Tract of the Japanese Beetle. Journ. Agr. Res., Vol. 41, No. 3, 1930.

Talbot, Mary. The Structure of the Digestive System in *Creophilus villosis*. Ohio Journ. Sci., Vol. XXVIII, No. 5, 1928.

Whittington, F. B. The Alimentary Canal of *Harpalus pennsylvanicus* Beg. (Carabidae: Coleoptera). Ohio Journ. Sci., Vol. XXV, No. 2, 1935.

ABBREVIATIONS USED ON PLATES

B M.......Basement Membrane.
C Mus.. ..Circular Muscles
CH...... Chitin.
COL...... Colon.
CT..... ..Connective Tissue.
EPI.......Epithelial Tissue.
FT........Fat Tissue.
IL...... ... Ileum.
IN .... Intima.
L MUS.....Longitudinal Muscles.
LU........Lumen.
M INT.....Mid-Intestine.
MALP ... Malpighian Tubules.
NI...... ..Nidus.
OES.......Oesophagus.
OV....... Oesophageal Valve.
PROV.....Proventriculus.
PV ...... Pyloric Valve.
RECT.....Rectum.
SEC... ...Secreting Cells.

EXPLANATION OF PLATES

Plate I

Fig. 1. A dorsal view of the alimentary tract in gross dissection.

Plate II

Figs. 2, 3, and 4. Three cross-sections of the oesophagus drawn to the same scale, showing the gradual enlargement of the oesophagus toward the mid-intestine.

Plate III

Fig. 5. Longitudinal section through the oesophageal valve, showing the sleeve-like extension of the oesophagus into the mesenteron.

Fig. 6. Cross-section of the extension of the oesophagus into the mesenteron showing the six chitinous fingers on the inner surface.

Plate IV

Fig. 7. Longitudinal section through the pyloric valve.

Fig. 8. Detail of cross-section of union of mid-intestine and hind-intestine showing the entry of Malpighian tubules.

Fig. 9. Diagrammatic drawing showing the distribution of the Malpighian tubules in a transverse plane at their point of entry into the hind-intestine.

Plate V

Fig. 10. Cross-section through the anterior colon.

Fig. 11. Cross-section through the rectum.

Fig. 12. Cross-section through the ileum.

Fig. 13. Longitudinal section through the colon and rectum, showing the constriction of the colon at the rectum, and the Malpighian tubules under the connective membrane of the colon.

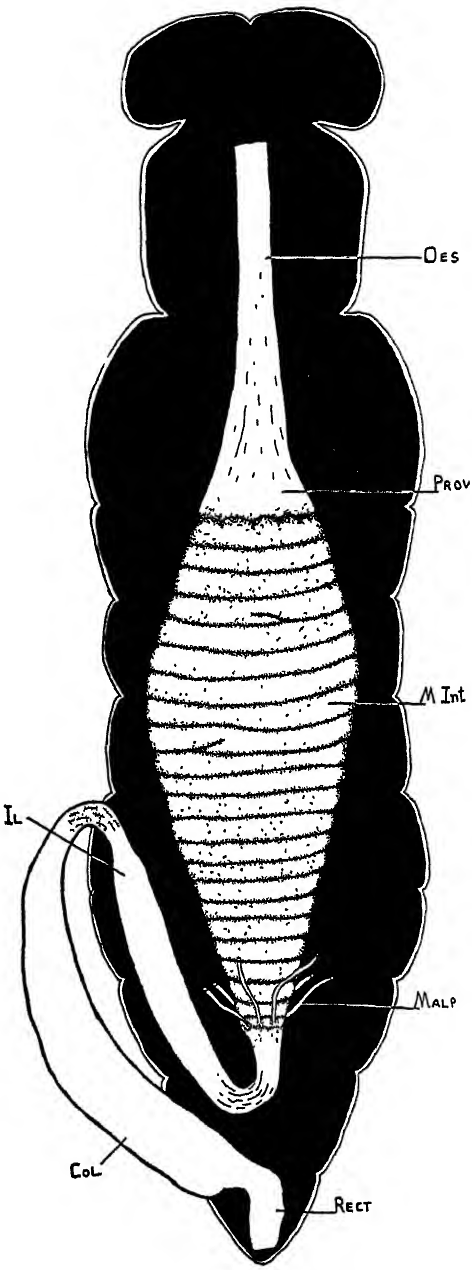


FIG. 1

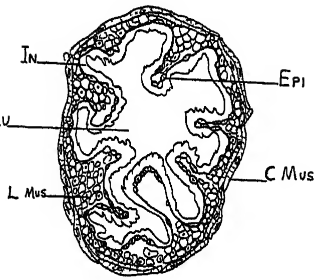


FIG 2

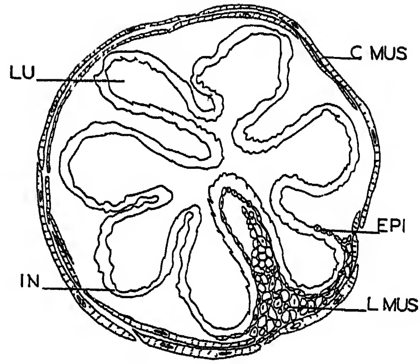


FIG 3

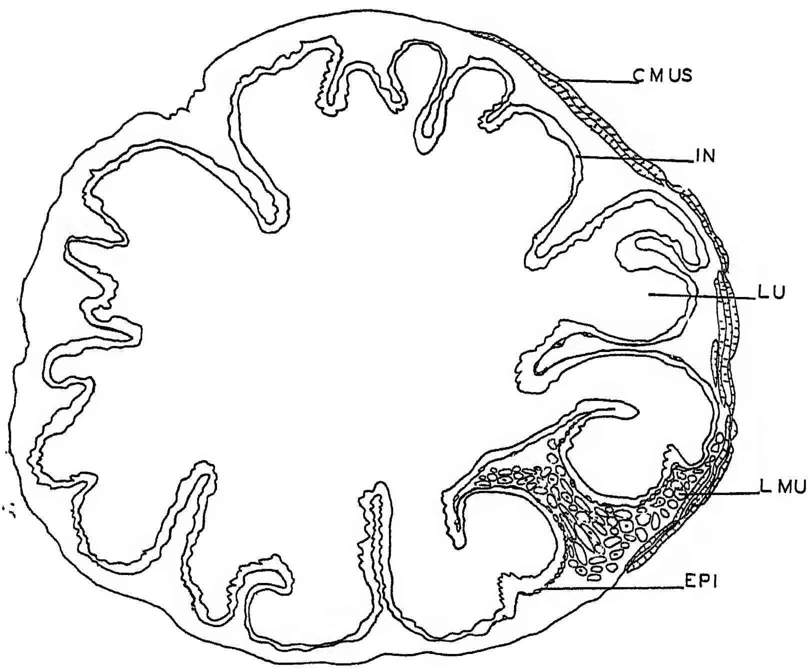
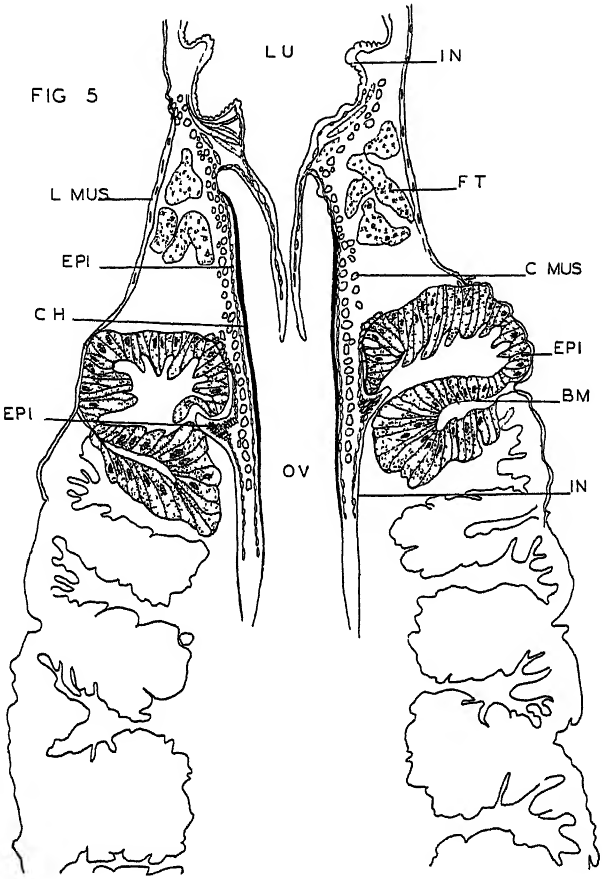


FIG 4

FIG 5



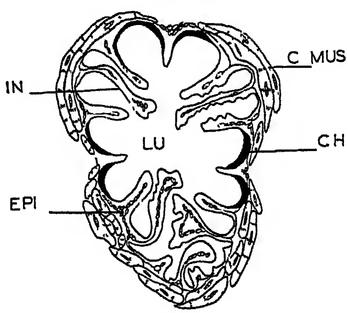


FIG 6

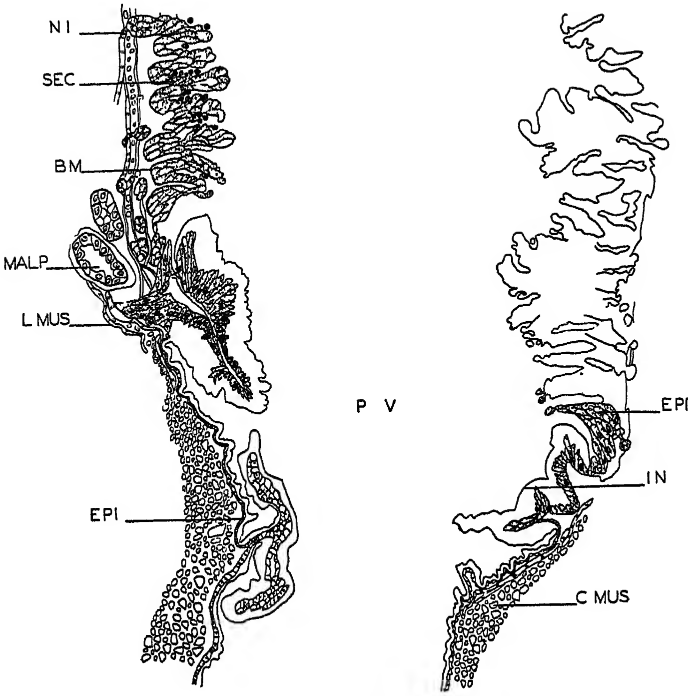


FIG 7

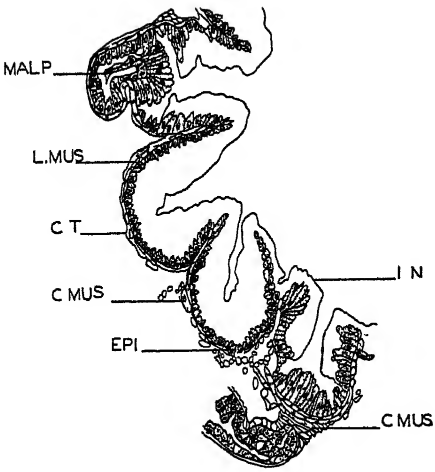


FIG 8

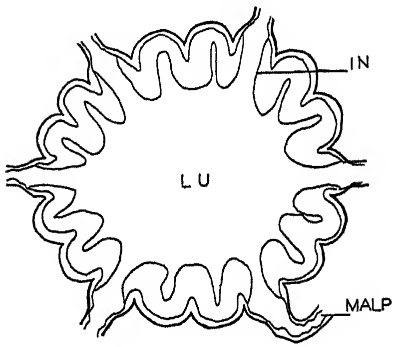


FIG 9

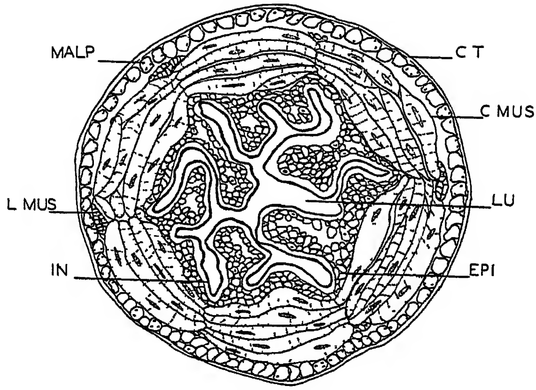


FIG 10

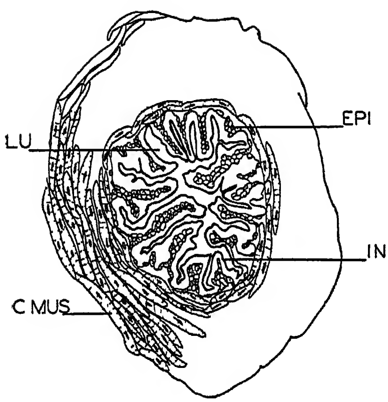


FIG 11

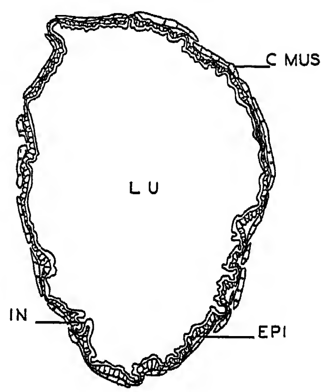


FIG 12

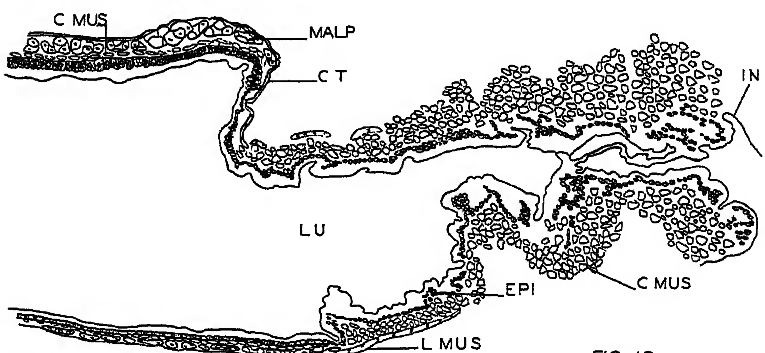


FIG 13

BOOK NOTICES

Fearfully and Wonderfully Made

Knowledge of the human organism grows apace, and it is fitting that from time to time attempts should be made to synthesize and correlate the available knowledge. The author of this volume, born and educated in Vienna, and with much chemical and medical research to her credit in the United States, has succeeded in bringing together in clear simple terms an astonishingly large number of facts about the anatomy, the physiology and the chemistry of man. Early in the book the author digresses to the philosophical consideration of asymmetric molecules and their bearing on living substance, and from time to time the phenomena of stereochemistry are reintroduced, until they become the dominant theme of the presentation. The author feels that stereochemistry reaches the very roots of biological principles, giving the unique specificity to the bio-molecule, and deplores the neglect of this science by biological workers. A most interesting philosophy of the living world is built around these considerations.

The hope is expressed that the interested layman will profit by the book, but it is the opinion of the reviewer that it would have to be an extremely inquiring and eager layman to wend his way through the tremendous mass of facts and emerge with much inkling of the author's philosophy. There is some tendency to redundancy in the volume, and a few grammatical errors, which detract from the pleasure of reading. However, the book should be stimulating to the philosophically minded biologist, bio-chemist and bio-physicist.—*L. H. S.*

Fearfully and Wonderfully Made, by Renee von Eulenburg-Wiener. xii+472 pp. New York, the Macmillan Co., 1938. $3.50.

Heredity Up-to-Date

Shull's "Heredity," for twelve years a standard and popular text in genetics, has been newly revised and issued in its third edition. The author has long been noted for his facile writing and clarity of presentation, and the new edition, extensively rewritten and reorganized, is a model of text-book preparation. Human material has been widely introduced throughout the book, without, however, replacing the chapters formerly given over to human heredity, which have themselves been considerably extended. The new knowledge of giant chromosomes has been made use of early in the book, the concept of genes and chromosomes being introduced in advance of examples of the inheritance of specific factors. Nearly 700 questions and problems of the objective type have been incorporated in the new edition, and a bibliography has been added. Practical applications of genetics, particularly to human beings, are thoroughly discussed. The book should appeal strongly to teachers and students alike.—*L. H. S.*

Heredity, by A. Franklin Shull. Third edition, xvii+442 pp. New York, the McGraw-Hill Book Co., 1938.

Cancer

Noting the success of the symposium type of program presented at the A.A.A.S. meetings, particularly as exemplified in the annual symposium of the American Society of Naturalists, the Medical Sciences Section determined to present at its 1936–37 meetings an extension of the plan. Accordingly there was prepared and offered a symposium on cancer, covering on a large scale a many-sided survey of this problem. Workers in various phases of cancer research presented papers at a series of sessions on seven successive days. As a result of the growing subsequent interest in the papers and the ensuing discussions, the symposium was printed in book form, and the present volume is the result. The thirty-one papers are clearly presented, well illustrated, and are by recognized authorities in the various fields. They are

grouped into the following general categories: heredity and constitutional factors; induction, stimulation and inhibition of tumorous growths; metabolism of cancerous tissue; radiation; general discussion of the cancer problem. While many of the papers are technical, others are more general and should be read by social workers and educators. Particularly Little's discussion of the social significance of cancer should have widespread publicity.—*L. H. S.*

Some Fundamental Aspects of the Cancer Problem. A Symposium. 248 pp. New York, the Science Press, 1937. $2.50.

Political Genetics Again

The controversy started by Graubard and by Muller against the more orthodox eugenists receives new fuel from this book by the distinguished geneticist of the University of London. While the book can not be said to be non-partisan, it is nevertheless a very fair presentation of the genetic implications involved in problems of racial inequalities, political discrimination and eugenical possibilities. The book is based on the Muirhead Lectures delivered at Birmingham University in 1937. In reading them one can only wish that it had been his privilege to hear them actually delivered, and perhaps to take part in the debate which must surely have followed their utterance.—*L. H. S.*

Heredity and Politics, by J. B S. Haldane. 202 pp. New York, W. W. Norton and Co., 1938.

Scientific Orientation

Ten members of the faculty of the University of Rochester have conspired to produce this introduction to the sciences. In keeping with the trend of the times, it surveys the broad field of science, integrating the various specialties into a unified whole. The integration is well thought out. For example, geology is introduced twice, once in more general aspect preceding the study of chemistry, and again in its minerological aspects following the chemical discussions. Chemistry itself is presented in two parts, separated by a discussion of physics. Other subjects portrayed are astronomy, biology, paleontology, physiology, bacteriology, psychology and mathematics. As is almost inevitable when ten authors write individual chapters of a text, some subjects are better presented than others, but on the whole the book seems a remarkably successful attempt to introduce the beginning student to science, its implications and its applications.—*L. H. S.*

An Orientation in Science, by Watkeys and Associates. x+560 pp. New York, the McGraw-Hill Book Co., 1938. $3.50.

Making Biology an Exact Science

It has been said that the task of the biologist of today is to raise biology to the rank of an exact science. Most people using the phrase "exact science" probably have in mind a science which adapts itself to mathematical treatment. But mathematics, or at least conventional mathematics, is not to be regarded as the only method for systematizing scientific knowledge, as is convincingly shown in the recent study by Dr. J. H. Woodger entitled "The Axiomatic Method in Biology." This book is very unique, since it represents the first attempt to apply to biology the *axiomatic* or *logistic* method, using the symbolic logic of Whitehead and Russell's celebrated work, the *Principia Mathematica*. This type of mathematics, though non-numerical, is perfectly controllable, perfectly rigorous, and enables one to decide quickly and decisively whether or not any possible statement concerning certain biological variables and their possible relationships is true. The purpose of the book is therefore to furnish the foundations for a new concise language for systematizing biological theory. It is the opinion of the author that the axiomatic method may thus serve to eliminate from biological literature disputes which arise solely from the faults of its language. It may also serve in discovering new unsuspected truths or even entire new analytical methods. Particularly convincing of this viewpoint are the words of Whitehead: "It follows that there are an indefinite

number of purely abstract sciences, with their laws, their regularities, and their complexes of theorems—all as yet undeveloped. We can hardly avoid the conclusion that Nature in her processes illustrates many such sciences. We are blind to such illustrations because we are ignorant of the type of regularities to look for."

The first two chapters describe the construction of axiom systems, the choice of various classes of arbitrarily defined variables, the properties of certain relationships which these may bear to each other, and rules concerning the manipulation of the logical symbols in the deduction of theorems Chapter III then develops an axiom system for biology and explores its applications in Genetics, Embryology, and Taxonomy. The author warns the reader that no startling revelations are to be expected among the theorems which are presented, since only the framework of a vast project has been undertaken. As a result of the logical inspection of Mendelism, however, some practical goals have already been attained, a system for grading the different types of inheritance, and formulae for computing the numbers of genotypes and genotypic matings under all conditions.

Anyone interested in theoretical biology will probably find much of interest in Professor Woodger's study, especially in the introductory chapters. To follow the outline of the biological calculus will, however, consume a great deal of time and study, and this will be necessary if the reader wishes to evaluate the book thoroughly and check for himself the author's claims for its usefulness —*C. W. Cotterman.*

The Axiomatic Method in Biology, by J. H. Woodger, with Appendices by Alfred Tarski and W. F. Floyd. x+174 pp. Cambridge University Press, 1937.

THE OHIO JOURNAL OF SCIENCE

VOL. XXXVIII NOVEMBER, 1938 No. 6

THE PRESENT STATUS OF WORK ON THE ECOLOGY OF AQUATIC INSECTS AS SHOWN BY THE WORK ON THE ODONATA[1]

CLARENCE HAMILTON KENNEDY
Ohio State University,
Columbus, Ohio

For a measure of ecological work on aquatic insects in general we will use as a yardstick the present status of our knowledge of the Odonata or dragonflies. This group is more nearly ready for ecological study than are other orders of aquatic insects because it is small in number of species and these are conspicuous so that their description is farthest advanced; also we are personally familiar with the dragonflies and the literature in this field. The size of our problem is further reduced because the small amount of ecological study on Odonata has been limited almost entirely to areas in Europe and North America.

Before proceeding further we wish to point out that one other and more restricted group of aquatic insects has received more study than have the Odonata. This is the family Culicidae, the mosquitoes and their relatives, which as early as 1879 were shown by Sir Patrick Manson to be the carriers of filaria worms. With the discovery in 1898 by Sir Ronald Ross that mosquitoes carried malaria and the further discovery two years later that yellow fever was transmitted by mosquitoes, this group of insects has had more intensive study than has any other group of insects of equal number of species. Because of its direct bearing on human welfare the mosquitoes have had all the forces of medical entomology brought to bear on them. Students of aquatic insects in general would do well to study the methods of research developed by

[1]Read December 30, 1937, in a Symposium on Hydrobiology given before the Limnological Society of America and the American Society of Zoologists at the Indianapolis meeting of the A. A. A. S.

men in medical entomology. Several recent publications give methods of culture, of population study and of control. (Peterson, 1934, 1937, and Needham, 1937).

But to return to Odonata: About 3,000 species of dragonflies have been described for the world fauna which count ranks them as a small order of insects. That many beetles have been described in America north of Mexico. Dragonfly species are usually distinct enough from near relatives to be easily described. However, we find a few widely spread forms which can be broken up into subspecific groups. The taxonomic problem at this point becomes difficult as a careful study of subspecific forms has value in direct proportion to the amount of cytological study and of the field study of these forms. Unfortunately for the larger aquatic insects these cannot be crossed and bred in a bottle as can many small flies. Further, in the case of predator insects such as Odonata we lack the extra specific characters which Kinsey, working on Cynips, found in the species of host oak, type of gall and in characters of the alternate generation. Nevertheless, students are already recognizing, but so far not describing, physiological, geographic and hybrid forms of Odonata. We cite two or three such problems:

Didymops transversa (Say) is common on cold spring-fed hill streams about Ithaca, New York, but at Raleigh, North Carolina, this dragonfly thrives on warm muddy ponds. Neither E. B. Williamson nor I could find any morphological differences between specimens from these very diverse environments. Are we dealing here with physiological species? In the Zoological Museum at Ann Arbor is a series of Macromia from the White River, Arkansas. This series of several hundred specimens is a mixture of two described species and an almost equal number of intermediate forms. Are the intermediate specimens hybrids? On the Wabash River in Indiana, no intermediate forms occur; the same two species on the Wabash are always distinct. A careful study of some western dragonflies show a plains form, an intermountain form, a Sonoran form and a Pacific Coast form. This type of distribution is that usually labelled geographic. All of these taxonomic problems are now facing the museum men who in the past have been limited to the study of dead insects. What catalogue name the museum taxonomist will ultimately concede to the student of living insects for such types of living aggregations of interbreeding individuals has

not as yet appeared. Kinsey has called them species. At this point we recommend the reader to Kinsey, "The Origin of Higher Categories in Cynips," 1936, and to Dobzhansky, "Genetics and the Origin of Species," 1937, and Anderson, "The Species Problem in Iris," 1936.

After naming his species the next great problem facing any field entomologist whether a student of land or of water insects is that of the population count. This is not a problem peculiar to aquatic entomology but is one of the more difficult problems facing all economic entomologists. The usual winged insect is an active animal which classes all moving objects larger than itself as possible enemies. Insects tend to avoid the census taker. The entomologist reporting an outbreak cannot assure his chief in Washington that he has not counted the same insect twice or even three times. Until entomologists can develop the technique of a fairly accurate census of insects in the field we will not be able to handle entomological problems statistically. Our mathematics of population will be too dependent on sampling which is something difficult to divorce from the desires of the sampler. Or just as bad, statistical studies may be based too much on laboratory populations. (See Snedecor, 1937.)

As Odonata are predators they occupy the peak of a food pyramid as defined by Elton (1927). Thus in general the individuals of any species in a limited area are not numerous as compared with the individuals of insect species on which they prey. In a small area dragonflies may appear numerous because the same conspicuous individuals fly constantly back and forth on the same beat. The only population study of value is that by Borror (1934) on *Argia moesta* Hagen, a common stream dragonfly of this region. In his study of Argia by a system of marks placed on their wings Borror was able to show the proportions of the two sexes, the sequence of color forms as individuals matured and to give a general idea of the total number in the area studied. C. B. Wilson (1920) attempted estimates on ponds at Fairport, Iowa, by counting the number of exuviae of nymphs at sampling stations.

The number of eggs laid by any species of dragonfly is unknown. Various estimates on partial data have been made. C. B. Wilson's studies on the Bureau of Fisheries' ponds at Fairport, Iowa (1920) are the best. This is data which will probably be difficult to obtain for the larger Anisoptera, but

perhaps can be had with some accuracy for the Zygoptera which can be reared in large cages, if these are placed in the bright sunshine.

Females of such could be caged with males and the eggs deposited actually counted. This, then, could be checked against ovarian egg-counts of virgin females which might prove to be the only count needed. Until we get the basic data of sound population counts and of reproductive ability we will be unable to apply mathematical formulae accurately to ecological problems. On its face it appears to be difficult to count insects that fly as well as do Odonata, but Borror's studies of Argia and all field observations indicate that the majority of the aquatic Odonata (some tropical forms are not aquatic) live as adults in very limited areas. This is especially true where water is in small or discontinuous ponds.

In Odonata and in all aquatic insects one of the basic limiting factors in distribution is the selection of the place of oviposition by the female. The structure of the odonate nervous system and casual observation indicate that the dragonfly is probably eye-minded. On this assumption the place for the eggs is probably selected through the sense of sight. Many female dragonflies will attempt to lay eggs on a wet automobile top or in ponds and reservoirs of crude petroleum. Only a multiplicity of field observations on the habits of particular species will define egg-laying habits. The literature at present contains only casual observations which too often are on egg-laying sites that in some way are unusual. As compared with the much more exact knowledge of oviposition in the codling moth and other pest insects our knowledge of odonate habits is crude in the extreme. Such observations on the selection of habitat by the female which are vital to any study of ecological distribution have not as yet been put on even the simplest statistical basis.

After having been deposited, the eggs of many dragonflies are subject to parasitization by the minute wasps of the family Mymaridae which can fly to them if laid above the water, or can swim to them when deposited in the water. Casual observation indicates that these are especially parasitic on the eggs of dragonflies which inhabit the desert type of pond that contains water only during the spring and early summer. Life history problems of this type could be worked out on the numerous small ponds of our glaciated area.

We have little, if any, knowledge of whether small fish or other aquatic predators eat dragonfly eggs. Eggs of many species of Anisoptera are scattered in the water in June and July when the broods of small fry are just off the nest. Except for some insectivorous birds and a few predaceous insects, insect eggs in general are not often attacked by predators.

The ecological distribution of dragonflies depends first on the flying adult which selects the new territory for hunting and egg deposition. The flying adult is aerial and not aquatic. The finer distribution of the species within the general aquatic habitat may depend more specifically on the behavior of the larva which is truly aquatic. The newly hatched larva may burrow in the mud or the sand of the bottom, may burrow in loose trash on the bottom, may cling to vegetation, or cling to rocks at any one of several levels. In a few species (Archilestes) the larva may even swim rather freely as do the darters and fish that lack an air bladder. We have little data as to whether larval distribution is a response to degree of light, to touch, to temperature, to currents or to varying amounts of gases or other solutes. Probably it is not often a matter of food.

With the great amount of field work on Odonata we are just beginning to get fair data on the seasons of flight. Wesenberg-Lund, of Denmark (1913), gave us our first extensive diagrams of seasons of flight. His form of diagram has been adopted in this country by E. M. Walker, C. F. Byers, the present writer and others. There is considerable casual evidence that species of dragonflies, particularly the one-brooded spring and early summer forms, are ready for emergence but do not emerge until some certain water temperature is reached. Even such simple data have not been collected on the common species, though it could be had by the use of a pocket thermometer.

To do all the things suggested so far, the species of dragonfly must be positively identified, whether in the egg stage, in one of a dozen larval stages or in the adult stage. As already stated the taxonomy of the egg stage and of larval stages is hardly begun. We now know the grown larvae in approximately half of the species north of Mexico, but we have only fair descriptions of the early or first stages of less than 20 of the 365 species for this area. For several years the writer has been collecting from entomological literature the known complete life histories of insects, those which give the length of

each of all the stages, and certain other data. Of American dragonflies we have only two or three such life histories. These species have been painstakingly reared by Professor P. P. Calvert and his student, Miss Lamb. (Calvert, 1929, 1934; Lamb, 1925.) Culture methods are summarized in the recent volume, "Culture Methods for Invertebrate Animals," edited by Professor Needham and sponsored by Section F. of the A. A. A. S. The usefulness of such work will depend on ample and exact illustrations of the various stages.

When we come to the food of dragonflies we have a few good papers based directly on stomach contents; one on Hawaiian species by Warren (1915) and the work of C. B. Wilson on dragonflies on the fish ponds at Fairport, Iowa, in 1920. Field observations have been brought together by Hobby (1933 and 1936).

In the matter of animals that eat Odonata we have a great many odds and ends of records in the literature on fish foods. The first important contributions in this field were made in Forbes' floating laboratory on the Illinois River in the early part of this century. The best bibliography of this literature is that by Gersbacher in the American journal, "Ecology" for July, 1937. Concerning animals which eat flying Odonata we have only the occasional published records of field observations. The present writer has just completed a manuscript which summarizes the data of the U. S. Biological Survey up to 1925 on dragonflies found in the stomachs of birds. Little of this material could be determined to species but it raises innumerable questions such as why certain species of birds take Odonata regularly while others closely related do not. It shows throughout the close relationship between the nature of the food, its abundance, and the size, structure and habits of the bird.

Concerning the actual ecological distribution of dragonflies we have many excellent lists of the dragonflies found in specific types of bogs, marshes, streams, ponds and the larger lakes. These are ecological data of a sort. Probably Professor E. M. Walker's papers on Canadian dragonflies deal more regularly with environmental conditions of the various species than do the writings of other American odonatists. I know of no paper which deals conclusively with the actual limiting factors of distribution as checked by experimental work of any extent.

No paper has appeared which deals with the ebb and flow of a dragonfly population over a period of years. In the

E. B. Williamson library on dragonflies, which is deposited in the Zoological Museum of the University of Michigan, are his detailed notes on the species of Odonata and their relative abundance each season over a period of more than twenty years as found flying on a button-bush woods-swamp (Vanemon Swamp) near Bluffton, Indiana. This is the best set of records we know of but they have never been organized or any part of them published. They show great fluctuations in relative abundance of species and apparently corroborate the writer's (Kennedy, 1922, p. 332) findings at Put-in Bay, Ohio, that gravid, fertilized females must fly long distances (one to five or more miles) and then must oviposit in any water available, where if unfavorable the species may exist one or more years then disappear.

This brief review of our knowledge of one of the most interesting groups of insects shows how little is really known concerning the lives of the less economic species. With the other aquatic insects in North America, the mayflies, caddisflies, stoneflies Hemiptera and Coleoptera less is known as in these groups even the taxonomy is in poor shape and little is known of geographic distribution.

The lack of knowledge of the distribution and habits of aquatic insects in North America can be laid partly to the fact that this area is so rich in undescribed species; the majority of men interested in insects have been tempted or even compelled to help describe new species. American insects are a biological gold mine. A graduate student at Ohio State University in two summers collected 2,000 species on the campus which is a flat city park. Many were new to science. This tremendous job of cataloguing has to go on before physiological and particularly before ecological work can be done with precision. Research on insects is no longer an amateur's job. Knowledge of insects has made amazing strides in two fields, that of medical entomology and that of agricultural entomology. In both fields large research funds have been available. Individual projects of study and control in the hundred thousand dollar level no longer cause comment and two projects, that of the European corn borer and that of the fruit fly in Florida have been operated in the ten million dollar level. In the United States and Canada are employed between 1,000 and 2,000 college trained men in research on insect pests. With the recent realization of the necessity of conservation in

its various forms we can anticipate more funds for studies of aquatic biology. Social pressures will force more funds into these fields of research.

Some of the most advanced ecological research being done at present is that by economic entomologists on various of our farm pests. Out of these lines of research are beginning to emerge general biological principles which help in the control of pests and aid in the prediction of serious outbreaks.

As far as I know the majority of American Odonatists are mostly interested in problems of taxonomy and of geographic distribution. Probably in order to make specific advances in the knowledge of the physiology of aquatic insects we will have to turn to men trained in the techniques of economic entomology. Peterson's recent volumes reviewing insectory methods and apparatus (1934, 1937) show us the great variety of types of research now being carried on by economic entomologists. Such men trained in the study of habits and in the techniques of experimental zoology could show us how to handle the problems of the ecology of aquatic insects. Too much of the work to date on aquatic insects has been done on a few specimens of a species by one man on a single table in the corner of some poorly equipped laboratory. The economic entomologists, if given funds, could operate with the large scale techniques developed in recent years by state and federal entomological staffs.

We append to this review a bibliography of key books and articles especially those with methods and good bibliographies of use in this subject.

BIBLIOGRAPHY

(If starred, not seen by author.)

Ecological Distribution in General

Braun-Blanquet. 1932. Plant Sociology, (Trans. by Fuller & Conrad), 439 pages. McGraw-Hill Book Co., Inc., New York and London.

Chapman, R. N. 1931. Animal Ecology. 448 pages. McGraw-Hill Book Co., Inc., New York and London.

Elton, Chas. 1927. Animal Ecology. 207 pages. Macmillan Co., New York.

Gersbacher, W. M. 1937. Development of Stream Bottom Communities in Illinois. Ecology 18 (3): 359–390. (Included for its bibliography.)

Hesse, R., W. C. Allee and K. P. Schmidt, 1937. Ecological Animal Geography. 597 pages. John Wiley and Sons, Inc., New York.

Morgan, Ann H. 1930. Field Book of Ponds and Streams. 448 pages. G. P. Putnam's Sons, New York and London.

Needham, J. G. and J. T. Lloyd. 1916. The Life of Inland Waters. 438 pages. The Comstock Publ. Co., Ithaca, N. Y.

Pearse, A. S. 1926. Animal Ecology. 417 pages. McGraw-Hill Book Co., New York and London.

Shelford, V. E. 1937. Animal Communities in Temperate America. 368 pages. University of Chicago Press, Chicago, Ill.

Methods and Problems

*Macgregor, M. E. 1927. Mosquito Surveys. A Handbook for Anti-malarial and Anti-mosquito Field Workers. London, 1927.

Needham, J. G. (Editor). 1937. Culture Methods for Invertebrate Animals. 590 pages. Comstock Publ. Co., Ithaca, N. Y.

Peterson, Alvah. 1934 and 1937. A Manual of Entomological Equipment and Methods. 1934. Part I. Plates 1–138, also conversion tables, etc. 1937. Part II. Plates 139–159 and pages 1–271, "Abstracts of Methods."

Shelford, V. E. 1929. Laboratory and Field Ecology. 608 pages. Williams and Wilkins Co., Baltimore, Md.

Snedecor, G. W. 1937. Statistical Methods applied to experiments in agriculture and biology. 356 pages. Collegiate Press, Inc., Ames, Iowa.

Vestal, A. G. 1938. A subject index for communities, including vegetation-components. Ecology, 19 (1): 107–125.

Wardle, R. A. 1929. The Problems of Applied Entomology. 587 pages. McGraw-Hill Book Co., Inc., New York and London.

Welch, P. S. 1935. Limnology. 471 pages. McGraw-Hill Book Co., Inc., New York and London

Speciation and Subspecific Groups

Anderson, Edgar. 1936. The species problem in Iris. Ann. Missouri Bot. Garden, 23: 457–509.

Dobzhansky, Theo. 1937. Genetics and the Origin of Species. 364 pages Columbia University Press, New York.

Kinsey, A. C. 1936. The Origin of Higher Categories in Cynips. Indiana University Publication, Science Series, 4: 1–334. Bloomington, Indiana.

Kinsey, A. C. 1937. An evolutionary analysis of insular and continental species. Proc. Nat. Acad. Sciences, 23 (1): 5–11.

Taxonomy and Biology of Aquatic Insects other than Odonata

Bettin, Charles. 1934. The Caddis Flies or Trichoptera of New York State. 576 pages. New York State Museum Bulletin No. 292. Albany, N. Y.

Claassen, P. W. 1931. Plecoptera Nymphs of America (North of Mexico). 199 pages. The Thomas Say Foundation of the Ent. Soc. Amer. (Vol. III), Lafayette, Ind.

Curran, C. H. 1934. The Families and Genera of North American Diptera. 512 pages. The Ballou Press, New York.

Frison, T. H. 1929. Fall and Winter stoneflies, or Plecoptera, of Illinois. Ill. Nat. Hist. Surv. Bull. 18 (2): 340–409.

Frison, T. H. 1935. The Stone Flies or Plecoptera of Illinois. Ill. Nat. Hist. Surv. Bull. 20 (4): 281–471.

Hungerford, H. B. 1919. The Biology and Ecology of Aquatic and Semiaquatic Hemiptera. Kans. Univ. Sci. Bull. 11: 1–328. Lawrence, Kans.

Johannsen, O. A. 1933–1936. Aquatic Diptera. Part I. Cornell Univ. Agr. Exp. Sta. Memoir 164, pp. 1–64, 24 plates. 1933. Part II. Memoir 177, pp. 1–62, 12 plates, 1935. Part III. Memoir 205, pp. 1–84, 18 plates, 1936. Parts IV and V Memoir 210, pp. 1–80, 18 plates, 1937.

Needham, J. G. and P. W. Claassen. 1925. A Monograph of the Plecoptera or Stoneflies of America North of Mexico. 397 pages. The Thomas Say Foundation of the Ent. Soc. Amer., Vol. II. Lafayette, Ind.

Needham, J. G. and Hortense B. Heywood. 1929. A Handbook of the Dragonflies of North America. 378 pages. Chas. Thomas, Springfield, Ill.

Needham, J. G., J. R. Traver and Yin-Chi Hsu. 1935. The Biology of Mayflies with a systematic account of North American species. 759 pages. Comstock Publ. Co., Ithaca, N. Y.

Ross, H. H. and T. H. Frison. 1937. Studies of Nearctic Aquatic Insects. Ill. Nat. Hist. Surv. Bull. 21 (3): 57–99.

Ecology of Dragonflies

Borror, D. J. 1934. Ecological studies of *Argia moesta* Hagen (Odonata: Coenagrionidae) by means of marking. Ohio Jour. Sci. 34 (2): 97–108. (The only study by marking dragonflies.)

Calvert, P. P. 1929. Different rates of growth among animals with special reference to the Odonata. Proc. Amer. Phil. Soc. 68 (3): 227–274. (Very long bibliography on problem of growth.)

Calvert, P. P. 1934. The rates of growth, larval development and seasonal distribution of dragonflies of the genus Anax (Odonata: Aeshnidae). Proc. Amer. Phil. Soc. 73 (1): 1–70. (Bibliography on Aeshnid larvae.)

Campion, Herbert. 1914. Some dragonflies and their prey. Ann. and Mag. Nat. Hist. (8) 13: 495–504.

Hobby, B. M. 1936. Dragonflies and their prey. Proc. Roy. Ent. Soc. London (A) 11 (6–12); 101–103. (Key to recent literature on subject.)

Kennedy, C. H. 1915. Interesting western Odonata. Ann. Ent. Soc. Amer. 8: 297–303. (Vertical annual migration on mountain streams.)

Kennedy, C. H. 1922. The ecological relationships of the dragonflies of the Bass Islands of Lake Erie. Ecology 3 (4): 325–336. (Species distribution on large lake and on small ponds.)

Kennedy, C. H. 1925. The distribution of certain insects of reversed behavior. Biol. Bull. 48 (6): 300–401 (A dragonfly with habits taking it out of usual distribution of its genus)

Kennedy, C. H. 1928. Evolutionary level in relation to geographic, seasonal and diurnal distribution of insects. Ecology 9 (4): 367–379. (Some factors in world distribution based largely on distribution and evolution of Odonata of the Americas.)

Lamb, Laura. 1925. A tabular account of the differences between the earlier instars of *Pantala flavescens* (Odonata: Libellulidae). Trans. Amer. Ent. Soc. 50: 289–312. (The only published keys to larval instars.)

Lyon, Mary B. 1915. The ecology of the dragonfly nymphs of Cascadilla Creek (Odon.). Ent. News 26: 1–15. (Food and shelter studied.)

Poulton, E. B. 1906. Predaceous insects and their prey. Trans. Ent. Soc. London for 1906, Part III, pp. 323–409. (Odonata, pp. 399–401, summary of published records.)

Somme, Sven. 1933. Birds as enemies of dragonflies (Odon.). Norsk. Ent. Tidsskr. 3 (3): 223–224. (Norwegian records.)

Walker, E. M. 1915. Notes on the Odonata of the vicinity of Go Home Bay, Georgian Bay, Ontario. Suppl. to 47th Ann. Rept. Dept. Marine and Fisheries. Sessional Papers No. 39 b, pp. 53–94, pls. III–IX. (Walker's best of several papers discussing dragonfly distribution in Canada.)

Warren, Alfred. 1915. A study of the food habits of the Hawaiian dragonflies or pinau with reference to their economic relation to other insects. (The most extensive study of the food of dragonflies.)

Wesenberg-Lund, C. 1913. Odonaten-Studien. Internat. Rev. Hydrobiol. und Hydrogeogr. for 1913, pp. 155–442. (Seasonal succession of species.)

Williams, F. X. 1936. Biological Studies in Hawaiian water-loving insects. Part II. Odonata or dragonflies. Proc. Hawaiian Ent. Soc. 9 (2): 273–349. (Non-aquatic dragonflies and others discussed.)

Wilson, C. B. 1920. Dragonflies and damselflies in relation to pondfish culture, with a list of those found near Fairport, Iowa. U. S. Bur. Fisheries Bull. 36 (882): 181–264 and index 2 pp (Excellent bibliography on habits of larvae.)

Biochemistry

This is the second edition, the first having been published in 1927. There are eighteen brief chapters on subjects usually included in a course in biochemistry, and in addition, chapters on alkaloids and the identification of organic compounds. Many laboratory tests and methods are included. Chapters on vitamins and hormones include many very recent formulae. This book is designed for use in review and is not intended to replace standard texts in biochemistry.—*J. B. Brown.*

Aids to Biochemistry, by E. A. Cooper and S. D. Nicholas, 2nd. Ed. William Wood and Co., Baltimore, 1938. $1.50.

A SPECIMEN OF SOLENOCHILUS PECULIARE FROM THE POTTSVILLE SERIES OF OHIO

MYRON T. STURGEON
Michigan State Normal College,
Ypsilanti, Michigan

INTRODUCTION

When Miller and Owen described *Solenochilus peculiare* from the Cherokee formation of Missouri in 1934, the holotype was the only specimen known to them. In February, 1936, while a graduate student at the Ohio State University, the writer discovered in the Geological Museum an unidentified specimen from the Lower Mercer limestone at Canton, Ohio, that also appears to be a representative of this species.

SYSTEMATIC DESCRIPTION

1934. *Solenochilus peculiare* Miller and Owen, University of Iowa, Studies in Natural History, Vol. XVI, No 3, pp 254–256, Pl. XIX, Figs. 1, 2.
Cherokee formation, Henry County, Missouri.

The Ohio specimen is a fragmentary, somewhat flattened, and almost completely exfoliated internal mold that belonged to a large and presumably subglobose conch. Only the ventral and ventrolateral portion of eight or possibly nine camerae and of the living chamber is preserved. The septate portion appears to possess the innermost layer of the shell and consequently is smoother than the living chamber. The entire preserved portion has a length of 180 mm. measured along the venter, and the conch probably had an original diameter of about 150 mm. The whorl's width at the juncture of the phragmacone and the living chamber is about 90 mm., but distortion and flattening may render this measurement somewhat unreliable.

The whorl is broadly rounded ventrally; its other surfaces are unknown. The internal mold of the phragmacone and also of the living chamber is longitudinally lirate, but only the median ventral lirae are discernible on the latter. The numerous lirae are relatively inconspicuous, closely spaced, and of two different strengths. The difference in strength is most apparent along the median line of the venter where the two median ventral lirae are separated by a wider space than the other lirae, and this space bears two of the less prominent lirae.

The septa are 11 to 12 mm. apart except the four adoral ones which are 8, 6, and 5 mm. apart, respectively, as the living chamber is approached. Even the last camera, upon close examination, is apparently divided into two slightly unequal chambers. The closer spacing of the adoral septa indicates a late mature or gerontic individual.

The sutures are slightly sinuous, and their preserved portions form a shallow, broadly rounded, ventral saddle that is bordered on each side by a similar lobe, and these lobes are in turn bordered by similar ventrolateral saddles. The sutures cannot be traced further dorsad than the ventrolateral saddles.

As in Miller and Owen's holotype the siphuncle is rather small and ventral in position and apparently was in contact with the ventral wall of the conch. The siphuncle is well enough preserved to show its peculiar and interesting structure. In one of the normal camerae the septal neck is 4.5 mm. long and the connecting ring is about 6 mm. long. A short distance apicad of the septum, the septal neck expands in diameter before contracting rather abruptly near its apicad end where it contacts the pyriform connecting ring. In contrast to the septal necks, the connecting rings are more abruptly contracted orad. The connecting rings not only exceed the septal necks in length but also in maximum diameter; and in one camera the connecting ring has an apparent diameter of 6 mm., and the septal neck has an apparent diameter of about 3 mm. In the shortened camerae adjacent to the living chamber the structure of the siphuncle is presumably modified but is not well shown.

REMARKS

This specimen appears to be conspecific with the specimen described by Miller and Owen as *Solenochilus peculiare*. Their holotype has been available for comparison through the courtesy of Mr. Owen. Both specimens are longitudinally lirate on the internal mold in a like manner. As far as can be determined the suture patterns are the same. The relative lengths and diameters of the septal necks and connecting rings and the nature and constriction of the siphuncular segments are comparable. In fact there are no apparent differences by which these two specimens can be separated specifically.

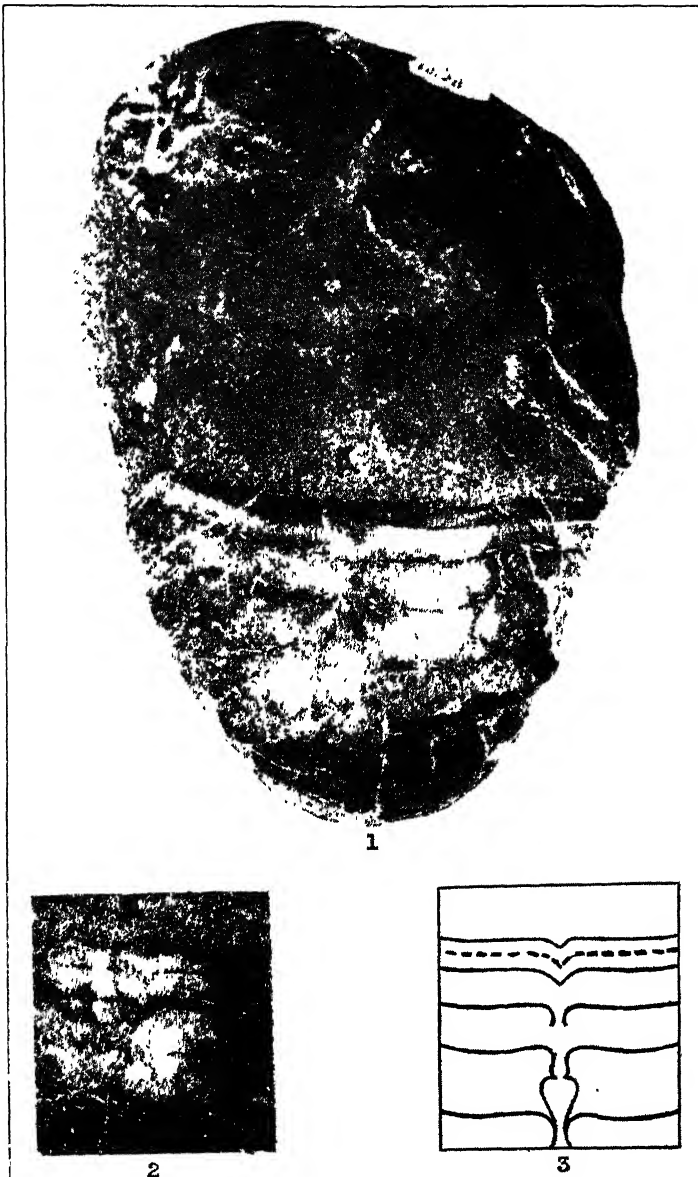
The finding of this species in strata of Pottsville age from widely separated geographic localities is significant, and the discovery of more restricted species in the same strata may lead to more exact stratigraphic correlation.

OCCURRENCE

Mr. H. H. Wolf collected the specimen from the Lower Mercer limestone member of the Pottsville series, Canton, Ohio. It was accessioned to the Ohio State University collection over 40 years ago and was unfortunately overlooked during the preparation of the bulletin on the Pottsville fauna of Ohio.

REPOSITORY

Geological Museum, Ohio State University, Columbus, Ohio, No. 10,128.



Figures 1–3. *Solenochilus peculiare* Miller and Owen. 1, ventral view showing the preserved portion of the phragmacone and living chamber, the nature of the siphuncle is visible in one or two of the camerae; 2, median ventral portion of the phragmacone adjacent to the living chamber photographed to show the nature of the longitudinal lirae; 3, diagrammatic representation of the sutures and siphuncle of the portion of the phragmacone shown in figure 2. All figures approximately × ¾. Canton, Ohio; from the Lower Mercer limestone, Pottsville series.

SIMPLE MODES OF INHERITANCE AND THE STUDY OF TWINS[1]

D. C. RIFE
The Ohio State University

Twins, both monozygotic and dizygotic, are of inestimable value in the study of the interaction of heredity and environment in the development of human traits. With the exception of mutations which may occur during the life of the individual, intra-pair variations in monozygotic twins are due to factors other than heredity. Many implications easily follow in the interpretation of experimental data based on the study of twins, not all of which are necessarily true One such implication is that when intra-pair variation in some trait is greater in dizygotic than in monozygotic twins, such differences are a measure of the extent to which heredity is responsible for the trait. While it is true that the differences between the two types of twins are due largely to heredity, yet it must be remembered that dizygotic twins are as similar in hereditary make-up as brothers and sisters, and thus such comparisons give us only a partial estimate as to the role played by hereditary factors. Comparisons of monozygotic twins with foster sibs or unrelated pairs of individuals reared in orphanages should give a more accurate basis for evaluating the role of heredity. Dizygotic twins and sibs, however, should also be included in such studies. Members of twin pairs are contemporaries, and thus have more similar environments than sib or random pairs with age discrepancies. Moreover, the prenatal environment of twins, due to crowding and possible imbalances of fetal blood supply, is different from that of single born individuals. While such conditions would not affect many genetic traits, such as blood types and skin pigmentation, yet it has been demonstrated that left-handedness and associated traits occur with greater frequencies in both types of twins than in single born individuals. Recent studies of dermatoglyphics (Cummins, Leche, and McClure, 1932; Leche, 1933) have brought

[1]Genetic Studies of Monozygotic Twins, No. VI.

out evidence that handedness has a genetic basis. As dizygotic twins and sibs have, on the average, the same degree of genetic similarity, comparisons of dizygotic twins with sibs should give us a measure of the part the unusual prenatal environment of twins plays in bringing about intra-pair differences. Differences between monozygotic twins reared together, minus the differences between dizygotic twins and sibs, should give us a much more accurate estimate of the part played by heredity, than comparisons only of the two types of twins.

The erroneous statement is sometimes made (Rosanoff et al., 1937) that although studies of twins are of great value in estimating the relative parts played by heredity and environment in the etiology of various traits, such data tell us absolutely nothing in regard to the *mode* of inheritance. It has recently been shown (Cotterman, 1937) that intra-pair sib comparisons can be used in the determination of whether or not a given trait could be due to single factor inheritance, although not necessarily indicating which phenotype is dominant. Similar methods can be employed in the analysis of data obtained from dizygotic twins, and may also be made to include a single pair of factors with incomplete dominance, sex-linked and sex-influenced factors.

A SINGLE PAIR OF FACTORS, WITH AND WITHOUT DOMINANCE

For a single pair of allelomorphs with incomplete dominance, A and a, let us allow p to represent the frequency of gene A, and q the frequency of gene a. Then, in a population which has reached quilibrium,

$$p + q = 1$$

Also

$$p^2 + 2pq + q^2 = 1$$
$$p^2 = \text{frequency of genotype AA}$$
$$2pq = \text{frequency of genotype Aa}$$
$$q^2 = \text{frequency of genotype aa}$$

Let us designate individuals of dominant phenotype by D, those of blending phenotype by I, and those of recessive phenotype by R. Table I shows all the possible types of matings, their frequencies, and also the relative frequencies of the six possible dizygotic twin or sib pair combinations.

Totaling, we find the frequencies of the various types of pairs to be as follows:

$$
\begin{aligned}
DD &= p^4 + p^3q + \tfrac{1}{4}p^2q^2 &&= \tfrac{1}{4}p^2(1 + p)^{2*} \\
II &= p^3q + 3p^2q^2 + pq^3 &&= p(1 - p)\,(1 + p - p^2) \\
RR &= \tfrac{1}{4}p^2q^2 + pq^3 + q^4 &&= \tfrac{1}{4}(1 - p)^2\,(2 - p)^2 \\
DI &= 2p^3q + p^2q^2 &&= p^2(1 - p^2) \\
RI &= 2pq^3 + p^2q^2 &&= p(1 - p)^2\,(2 - p) \\
DR &= \tfrac{1}{2}p^2q^2 &&= \tfrac{1}{2}p^2(1 - p)^2
\end{aligned}
$$

In an allelomorphic pair where dominance is complete, individuals would necessarily be D or R, and pairs DD, DR and

TABLE I

	Matings	Offspring					
		DD	II	RR	DI	RI	DR
p^4	♂ AA × ♀ AA	p^4	0	0	0	0	0
$2p^3q$	AA × Aa	$\frac{1}{2}p^3q$	$\frac{1}{2}p^3q$	0	p^3q	0	0
p^2q^2	AA × aa	0	p^2q^2	0	0	0	0
$2p^3q$	Aa × AA	$\frac{1}{2}p^3q$	$\frac{1}{2}p^3q$	0	p^3q	0	0
$4p^2q^2$	Aa × Aa	$\frac{1}{4}p^2q^2$	p^2q^2	$\frac{1}{4}p^2q^2$	p^2q^2	p^2q^2	$\frac{1}{2}p^2q^2$
$2pq^3$	Aa × aa	0	$\frac{1}{2}pq^3$	$\frac{1}{2}pq^3$	0	pq^3	0
p^2q^2	aa × AA	0	p^2q^2	0	0	0	0
$2pq^3$	aa × Aa	0	$\frac{1}{2}pq^3$	$\frac{1}{2}pq^3$	0	pq^3	0
q^4	aa × aa	0	0	q^4	0	0	0

RR. The frequency of DD pairs would be the sum of the frequencies of DD, II, and DI pairs with incomplete dominance which equals $\frac{1}{4}p(4 + 5p - 6p^2 + p^3)$. Similarly, the frequency of DR pairs would equal the sum of DR and RI pairs with incomplete dominance, which is $\frac{1}{2}(1 - p)^2\,(4 - p)$. The frequency of RR pairs would be the same for complete as for incomplete dominance, $\frac{1}{4}(1 - p)^2(2 - p)^2$.

*The writer is indebted to Mr. C. W. Cotterman for aid in the simplification of formulae.

TABLE IIA

Gene Frequencies P	Gene Frequencies Q	Single Pair Factors with Blending DD	II	RR	DR	DI	RI
.01	.99	.0000255025	00999801	9703235025	000049005	00009999	01950399
05	95	.00068906	.04975625	857937065	.001128125	00249375	.08799375
10	.90	.003025	.0981	731025	00405	.0099	1539
15	.85	.0074328125	.14370625	.6182453125	008128125	02199375	.20049375
.20	.80	.0144	1856	.5184	0128	0384	.2304
.25	.75	.0244140625	22265625	4306640625	017578125	05859375	24609375
.30	.70	.038025	2541	354025	02205	.0819	2499
.35	.65	.0558140625	.27925625	.2875640625	0258781255	10749375	.24399375
.40	60	.0784	.2976	2304	0288	1344	2304
.45	.55	.1064390625	.30875625	1816890625	030628125	16149375	21099375
50	.50	.140625	.3125	140625	.03125	.1875	1875
.55	.45	1816890625	.30875625	1064390625	.030628125	21099375	16149375
.60	.40	.2304	.2976	0784	.0288	.2304	1344
.65	.35	.2875640625	.27925625	.0558140625	0258781255	24399375	.10749375
70	30	354025	.2541	038025	02205	2499	.0819
75	25	4306640625	.22265625	0244140625	017578125	.24609375	.05859375
.80	.20	.5184	.1856	.0144	0128	.2304	0384
85	.15	.6182453125	.14370625	0074328125	.008128125	20049375	02199375
90	.10	731025	.0981	003025	.00405	1539	.0099
.95	05	.857937065	.04975625	.00068906	001128125	08799375	00249375
99	.01	.9703235025	00999801	.0000255025	000049005	.01950399	00009999

TABLE IIb

Gene Frequencies		Complete Dominance		
p	q	DD	DR	RR
01	99	0101235025	019552995	.9703235025
05	95	05293906	089121875	857937065
10	90	111025	15795	731025
15	85	1731328125	208621875	6182453125
20	80	.2384	2432	.5184
25	75	3056640625	263671875	4306640625
30	70	.374025	27195	354025
.35	65	4425640625	.269871875	2875640625
40	60	5104	2592	2304
45	.55	5766890625	241621875	.1816890625
50	50	.640625	21875	.140625
55	45	7014390625	192121875	1064390625
.60	40	7584	1632	0784
65	35	8108140625	133371875	0558140625
.70	30	858025	10395	038025
75	25	8994140625	076171875	0244140625
80	20	.9344	0512	0144
.85	.15	9624453125	030121875	0074328125
.90	10	983025	01395	003025
.95	05	995687065	003621875	00068906
99	.01	.9998255025	000148995	0000255025

Table II shows the expected ratios of the various types of pairs, for different values of p and q, for both complete and incomplete dominance. It can readily be seen that the amount of information concerning the inheritance of a trait conveyed by obtaining the ratios of the various types of pairs depends upon the number of pairs studied, and also, to some degree, upon the frequencies of the genes involved. If the frequency of the recessive gene (where dominance is complete) were .80, the ratio obtained from the various types of pairs is approximately the same as when q has a frequency of .60, but in this

instance the total numbers of the two phenotypes in the population studied would enable us to determine which gene was dominant. At a frequency of approximately .70 for q, DD and RR pairs occur with equal frequency, and DR pairs at their maximum frequency, .27+. We would not, of course, determine which phenotype was dominant. If, in a group of dizygotic twins or sib pairs, the percentage of DR pairs significantly exceeds 27%, variation in the trait cannot be due solely to inheritance, based on a single pair of autosomal genes with complete dominance.

TABLE III

Frequencies	Matings	♂ ♂			♀ ♀			♂ ♀		
		DD	DR	RR	DD	DR	RR	DD	DR	RR
p^3	♂ A × ♀ AA	p^3	0	0	p^3	0	0	p^3	0	0
$2p^2q$	A × Aa	$\frac{1}{2}p^2q$	p^2q	$\frac{1}{2}p^2q$	$2p^2q$	0	0	p^2q	p^2q	0
pq^2	A × aa	0	0	pq^2	pq^2	0	0	0	pq^2	0
p^2q	a × AA	p^2q	0	0	p^2q	0	0	p^2q	0	0
$2pq^2$	a × Aa	$\frac{1}{2}pq^2$	pq^2	$\frac{1}{2}pq^2$	$\frac{1}{2}pq^2$	pq^2	$\frac{1}{2}pq^2$	$\frac{1}{2}pq^2$	pq^2	$\frac{1}{2}pq^2$
q^3	a × aa	0	0	q^3	0	0	q^3	0	0	q^3

In a trait where dominance is incomplete, the situation is more complex, because there are six instead of three types of pairs. Consequently, a much larger number of pairs would be necessary to obtain an accurate ratio. There is some compensation for this difficulty, in that where six instead of three types of pairs are included in the ratio, the precision of our ratios is likewise greater. If not enough pairs can be collected for significant ratios of all six types, pairs may be classed as concordant or discordant, the former group being the sum of DD, II and RR pairs, and the latter group the sum of DI, RI and DR pairs. Where dominance is complete, concordant pairs would of course include DD and RR pairs, and discordant would still include only DR.

There has been considerable data brought together by various investigators, giving ratios of concordant to discordant

dizygotic twin pairs, in respect to a number of traits. Unfortunately, almost without exception, only one type of concordant pair is considered, and moreover, the twins have been selected for the trait in question. Thus we have no way of knowing, from such data alone, the frequencies of the various phenotypes in the population as a whole.

SEX-LINKED FACTORS

When dealing with sex-linked factors, we have nine types of pairs, depending on sex as well as trait phenotype. Table III shows the various types of matings, and the ratios of the various types of pairs.

Totaling, we find the frequency of each type of combination to be as follows:

$$
\begin{array}{lll}
DD\ \male & = p^3 + \tfrac{3}{2} p^2q + \tfrac{1}{2}pq^2 & = \tfrac{1}{2}p(1 + p) \\
DR\ \male & = p^2q + pq^2 & = p(1 - p) \\
RR\ \male & = q^3 + \tfrac{3}{2} pq^2 + \tfrac{1}{2}p^2q & = \tfrac{1}{2}(1 - p)(2 - p) \\
DD\ \female & = p^3 + 3p^2q + \tfrac{3}{2} pq^2 & = \tfrac{1}{2}p(3 - p^2) \\
DR\ \female & = pq^2 & = p(1 - p)^2 \\
RR\ \female & = q^3 + \tfrac{1}{2}pq^2 & = \tfrac{1}{2}(1 - p)^2(2 - p) \\
DD\ \male\ \female & = p^3 + 2p^2q + \tfrac{1}{2} pq^2 & = \tfrac{1}{2}p(1 + 2p - p^2) \\
DR\ \male\ \female & = p^2q + 2pq^2 & = p(1 - p)(2 - p) \\
RR\ \male\ \female & = \tfrac{1}{2}pq^2 + q^3 & = \tfrac{1}{2}(1 - p)^2(2 - p)
\end{array}
$$

Table IV shows the various ratios for the three types of pairs for various gene frequencies. It will be noted that the varying percentages of discordant male pairs form a symmetrical distribution, the highest value being .25 where both genes have a frequency of .50. This frequency is, of course, the same as that for random male pairs in the general population. While the fact that nine types of pairs existing in sex-linked factors introduces greater complications, there is some compensation in that differences in the occurrence in the two sexes would rather easily become apparent, and the only other type of inheritance likely to show such sexual discrepancies would be that involving sex-influenced factors.

SEX-INFLUENCED FACTORS

In a single factor trait which shows reversal of dominance in the two sexes, we can readily obtain the expected ratios at various gene frequencies for both male and female pairs by reference to Table II. Suppose, for example, male pairs fit

TABLE IV

		Sex-Linked Factors ♂ ♀			♂ ♂			♀ ♀		
P.	Q.	DD	DR	RR	DD	DR	RR	DD	DR	RR
.01	.99	.0050995	019701	.9751995	00505	0099	98505	0149995	.009801	.9751995
05	95	.0274375	092625	8799375	02625	0475	.92625	07493755	.045125	8799375
.10	90	0595	171	.7695	055	09	.855	.1495	081	.7695
.15	85	0958125	.235875	6683125	08625	1275	.78625	.2233125	108375	.6683125
20	.80	136	.288	.576	12	16	.72	.296	128	.576
25	75	1796875	.328125	4921875	15625	1875	65625	.3671875	140625	.4921875
.30	.70	.2265	.357	4165	195	21	.595	4365	1470	.4165
35	65	2760625	375375	3485625	23625	2275	53625	.5035625	147875	.3485625
40	60	328	384	.288	28	24	48	.568	144	288
.45	55	3819375	.383625	.2344375	32625	2475	42625	.6294375	.136125	2344375
50	50	4375	375	1875	375	25	375	6875	1250	.1875
55	.45	4943125	358875	1468125	42625	2475	.32625	741825	.111375	.1468125
60	.40	.552	336	112	48	24	28	.792	096	.112
65	35	6101875	307125	.0826875	53625	2275	23625	8376875	079625	.0826875
.70	30	.6685	273	.585	595	21	195	8785	.063	.0585
.75	.25	.7265625	234375	0390625	.65625	.1875	.15625	.9140625	.046875	.0390625
80	20	.784	.192	.024	.72	.16	.12	944	.032	024
85	15	.8404375	146625	.0129375	.78625	1275	08625	9679375	.019125	.0129375
.90	10	.8955	.099	.0055	.855	09	055	9855	009	.0055
.95	05	.9488125	049875	.0013125	.92625	.0475	02625	.9963125	0023750	.0013125
.99	.01	.9899505	.009999	.0000505	98505	.0099	.00505	9998505	.000099	.0000496

single factor inheritance with complete dominance, with p at a frequency of .10, and q at a frequency of .90. If sex-influenced, female pairs should fit the same mode of inheritance, but at a value of .90 for p. and .10 for q.

TABLE V

P	Q	Sex-Influenced Factors, ♂ ♀ Pairs		
		DD	DR	RR
01	99	0194794975	019849005	9609714975
05	95	1499296875	033634375	8164359375
10	90	151975	10305	744975
15	85	1969359375	263128125	.5399359375
20	80	2256	3328	.4416
25	75	2412109375	392578125	3662109375
30	70	246975	44205	310975
35	65	2460609375	480878125	2730609375
40	60	2416	.5088	2496
45	55	2366859375	525628125	2376859375
50	50	234375	53125	234375
.55	45	2376859375	525628125	2366859375
.60	40	2496	5088	2416
.65	35	2730609375	480878125	.2460609375
70	30	310975	44205	246975
75	25	3662109375	392578125	2412109375
80	20	4416	3328	2256
85	.15	.5399359375	263128125	.1969359375
90	10	.744975	10305	151975
95	05	.8164359375	033634375	1499296875
99	01	.9606714975	019849005	0194794975

In unlike-sexed pairs, we find upon examination of Table I, the following ratios:

$$DD = 2p^3q + \tfrac{3}{4}\, p^2q^2 + p^4 \quad = \tfrac{1}{4}p^2(3 - p\,(1 + p)$$
$$DR = 2p^3q + 2pq^3 + 4.5p^2q^2 = p(1 - p)\,(4 + p - p^2)$$
$$RR = 2pq^3 + \tfrac{3}{4}\, p^2q^2 + q^4 \quad = \tfrac{1}{4}(1 - p)^2(4 - p^2)$$

Table V gives the ratios at various gene frequencies.

It can readily be seen that where a trait is dependent solely on heredity, based on a single pair of allelomorphs, the ratio of concordant pairs and discordant pairs may be of value in suggesting the mode of inheritance. Just how precise the information may be depends upon the number of pairs investigated, and the gene frequencies. If no discordant pairs are found in identical twins, and if fraternal twins show significantly more than 27% of discordant pairs, where only two phenotypes are known and where the sex of the pairs does not affect the ratios, we can be sure that more than a single pair of genes is involved in the expression of the trait in question.

TABLE VI

Matings	Frequency	Proportion of Discordant Pairs in Progeny	Proportion of Total
♂ ♀ AO × AA	0245	0	0
AO × AO	1225	375	0459375
AO × OO	1575	5	07675
AO × BB	00175	5	00875
AO × BO	03325	75	.0264375
AO × AB	01050	5	00525
AA × AA	0049	0	0
AA × AO	0245	0	0
AA × OO	0315	0	0
AA × BB	00035	0	0
AA × BO	00665	.5	003375
AA × AB	.00210	.5	.00105
OO × AA	0315	0	0
OO × AO	1575	.5	.07875
OO × OO	.2025	0	0
OO × BB	.00225	0	0
OO × BO	04275	5	021375
OO × AB	0135	5	00675
BB × AA	00035	0	0
BB × AO	.00175	5	.00875
BB × OO	.00225	0	0

TABLE VI—[*Continued*]

Matings	Frequency	Proportion of Discordant Pairs in Progeny	Proportion of Total
♂ ♀ BB × BB	000025	0	0
BB × BO	.000475	5	0002375
BB × AB	00015	5	000075
BO × AA	00665	5	003375
BO × AO	03325	.75	0264375
BO × OO	.04275	5	0213750
BO × BB	000475	0	0
BO × BO	.009025	375	00336975
BO × AB	00285	.5	001425
AB × AA	.00210	.5	00105
AB × AO	01050	.5	00525
AB × OO	0135	5	00675
AB × BB	00015	5	000075
AB × BO	00285	5	001475
AB × AB	0009	375	0003375
		Total discordant	.35440725

MULTIPLE ALLELOMORPHS

While it is possible to set up tables for ratios of various types of pairs at given gene frequencies for series of three or more allelomorphs, similar to those given for single pairs of allelomorphs, the complications are tremendously increased and their practical applications in determining modes of inheritance would not seem to be sufficient to justify their construction. If the frequencies of the various genes and their interactions are known, however, such knowledge may be of value in twin diagnosis. Let us consider how the blood groups may be of value in this connection.

Genes A and B show incomplete dominance in respect to each other, but both are dominant to gene O. The frequencies of these genes vary, of course, depending upon race. In North American Whites (Snyder, 1927) the relative percentages of the blood groups are approximately: A—42, O—45, B—10,

and AB—3. Allowing p to equal the frequency of gene A, q the frequency of gene B, and r that of O, we obtain the following genotypic ratio: AA—.07; AO—.35; BB—.005; BO—.095; OO—.45; and AB—.03. Let us now determine what percentage of fraternal twin and sib pairs would be expected to be discordant in blood group. As shown in Table VI, this can be accomplished by tabulating the frequency of all types of matings, and determining what percentage of paired offspring would be discordant. As shown in Table VI we should find such variation in approximately 35% of fraternal twins, in North American Whites.

Various research workers (Diehl and von Verschuer, 1933; Levit, 1935; Rife, 1934–37) have used blood grouping as confirmatory evidence of monozygosity, and in a total of several hundred pairs, assumedly monozygotic twins have never shown intra-pair variation in blood groups. There is the possibility, however, that selection for monozygosity may have been too rigid, and thus some less similar pairs of monozygotic twins classed as dizygotic. In a large group of twins, separated into classes according to zygosity, we should expect, if selection for monozygosity has not been too rigid, approximately 65% of the dizygotic twins to be of the same blood group. If the percentage of concordance exceeds this figure significantly, we may be justified in assuming that selection for identity has been too rigid, and that some of the assumedly dizygotic twins are monozygotic.

The M and N blood reactions may also be of use in this connection. In North American Whites (Wiener, 1934; Hyman, 1935) the relative proportions of the three types are MN—50, M—28, and N—22. M and N are a pair of allelomorphs lacking dominance. The frequency of gene M is therefore .53 and that of N, .47. Referring to Table IIa, we find that the ratio of discordant types (sum of ratios in columns 4, 5 and 6) in blending inheritance, with gene frequencies of from .45–.55 to .50–.50 is approximately 40%. As the M and N genes and the blood group genes have been shown not to be linked (Wiener, 1932), the proportion of sib and dizygotic twin pairs showing concordance in both traits should approximate $.65 \times .60 = .39$. In a similar manner, more independent traits whose mode of inheritance and gene frequencies are known could be added to the formula, thereby increasing its efficiency.

CONCLUSIONS

Comparisons of identical with fraternal twins are of primary importance in obtaining partial evaluations of the relative roles played by heredity and environment in bringing about variation in human traits. Where simple types of inheritance are involved, data obtained from fraternal twins may be of value in suggesting the exact mode of inheritance. Such data, while not affording the most efficient method for determining manners of inheritance, are valuable by-products of twin studies primarily designed with other objectives in mind. In twin diagnosis, data taken from assumedly dizygotic twins concerning the occurrence of traits, whose manners of inheritance are known, may be of value in determining whether or not selection for monozygosity has been too rigid.

REFERENCES

Cotterman, C. W. 1937. Indication of Unit Factor Inheritance in Data Comprising but a Single Generation. Ohio Journal Science 37: 127–140.

Cummins, H., S. Leche, and K. McClure. 1931. Bimanual Variation in Palmar Dermatoglyphics. The American Journal of Anatomy 48: 199–230.

Diehl, Karl and O. F. von Verschuer. 1933. Zwillingstuberkulose. Gustav Fischer, Jena.

Hyman, Harriet S. 1935. Genetic Studies of the Agglutinogens M and N. The Journal of Immunology 29: 223–237.

Leche, Stella M. 1915. Handedness and Bimanual Dermatoglyphic Differences. The American Journal of Anatomy 53: 1–51.

Levit, S. G. 1936. Proceedings of the Maxim Gorky Medico-Genetical Research Institute. State Publishing House for Biological and Medical Literature, Leningrad.

Rife, D. C. 1933. Genetic Studies of Monozygotic Twins. Journal of Heredity 24: 339; 1938, ibid. 29: 83–90.

Rosanoff, Aaron J., L. M. Handy and Isabel Rosanoff Plesset. 1937. The Etiology of Mental Deficiency, with Special Reference to Its Occurrence in Twins. Psychological Monographs XLVIII, No. 4.

Snyder, L. H. 1929. Blood Grouping in Relation to Clinical and Legal Medicine. The Williams and Wilkens Co., Baltimore.

Wiener, A. 1932. Method of Measuring Linkage in Human Genetics, With Special Reference to Blood Groups. Genetics 17: 335–350.

———. 1934. Blood Groups and Blood Transfusion. Charles C. Thomas Co., Springfield, Ill.

Some Good Pointers for the Taxonomist

The discussions of problems in systematic work as presented in "Procedure in Taxonomy" are of value to all workers, especially the younger workers in this field. Many of the more important sources of difficulty in work of this type are briefly discussed; such as for instance taxonomic units employed by various authors and the excessive number of categories of this type; the use, selection, preservation and kinds of type specimen; the description of the type; specific names and their choice; the many questions of synonymy; the use of Latin terms and their abbreviations and a rather complete appendix dealing with the more important international rules of Zoölogical Nomenclature and the summaries of the opinions rendered by the international committee. The discussion is concisely and ably presented.

—*Dwight M. DeLong.*

Procedure in Taxonomy, by Edward T. Schenk and John H. McMasters. vii+72 pp. Stanford University Press, Stanford University, California, 1937. $2.00.

THE LARVAL AND PUPAL STAGES OF TWO TROPICAL AMERICAN BUTTERFLIES

H. F. STROHECKER
University of Miami and Kenyon College

Athena petreus (Cramer) has become established in southern Florida and is now a frequently encountered insect in the "hammocks" around Miami. So far as I know no description of the early stages of any species of *Athena* has been published and it was with some excitement that I watched oviposition by a female of *petreus* on a small fig tree. The fig species, determined by Dr. Phillips of the University of Miami, was *Ficus brevifolia*. Two eggs were obtained but the attempt to rear the larvae was unsuccessful. Five days later, on May 30, a full grown larva was found, again on *F. brevifolia*. This larva,

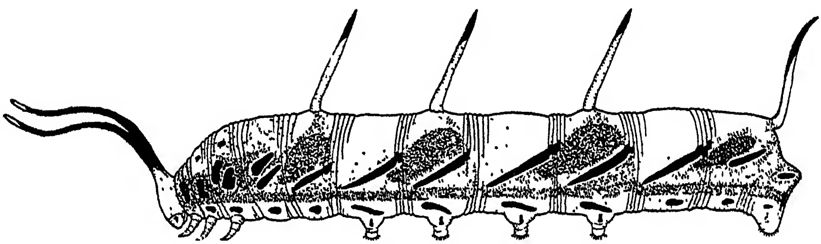


Fig. 1. Larva of *A. petreus*.

when brought into the laboratory, immediately prepared for pupation and the chrysalis was revealed on June 1. The period of pupation was surprisingly short; a male butterfly emerged on June 5. The drawings accompanying this article were made from notes and from photographs which were not clear in some details such as segmentation. The figures, while diagrammatic to some extent, will enable recognition of the stages should they be encountered.

Larva.—General color brick red; head lighter in color and bearing a pair of flexible, white-tipped filaments. The dorsal surface of the body bears four high spines; these red with black tips. The caudal spine is edged with white. Three pink, saddle-like areas lie between the spines. On each side of every segment is a shining black, elongate

mark; these edged with white except on the first three segments. There are also irregular, opaque black marks lateral to and below the spines. Length of larva, 37 mm.

Chrysalis.—Light green in color with the dorsum near middle armed with a high forked spine (black). A series of black spines of various heights succeeds this posteriorly with several very short spines scattered on the sides. The dorsum of the thorax bears a shining black boss. On the humeral angle there is a long, black and green spine curved forward and downward. Length of pupa, 17 mm.

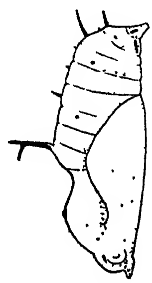



Fig. 2. (Left) Chrysalis of *A. petreus*.
Fig. 3. (Right) Humeral spine of chrysalis.

A number of hesperiid larvae were found on small specimens of red mangrove, *Rhizophora mangle*, which were in heavy shade cast by higher growth. Only one of these was reared and yielded a specimen of *Phocides batabano* (Lucas). All the remaining larvae, eighteen in number, were parasitized and eventually died. The early instars of the larva of *batabano* are purplish-brown with a saffron yellow ring encircling each segment and a similarly colored spot on the head at the base of each mandible. In the last instar the larva becomes covered with a powdery, white exudate which masks the markings. Its features are typically hesperiid though the body is stouter than in most N. A. species of this family. The pupa is without conspicuous markings or structures which would permit identification. No doubt close comparisons with other hesperiid pupae would reveal differential characters.

THE IMPORTANCE OF PHYLOGENETIC TAXONOMY IN SYSTEMATIC BOTANY[1]

JOHN H. SCHAFFNER

The main interest of the older taxonomists was the discovery and description of species, which to them were units or entities self-contained and complete as they had come from the hand of the Creator. Linnaeus was so far possessed with this species idea that he wrote the well-known phrase: "The tyro makes systems, the expert makes species." However expert Linnaeus may have been in making species, he certainly was the most extreme tyro when he attempted to bring some systematic order into the chaos of the known species of his time. He made 23 classes of Phanerogamia and one class of Cryptogamia, bunching together into this class all the known Algae, Fungi, Liverworts, Mosses, Ferns, Horsetails and Lycopods.

When Darwin wrote his first great work on evolution, it was still the origin of species, the more or less discrete units of plants and animals, that was the main object of interest. But the proper study of the species should be made in its relation to all the species in the genus. When this is done the isolated species unit becomes of subordinate interest and importance both in evolution and taxonomy.

Just as when one is studying Shakespeare's Hamlet, for example, one can study the isolated words and recognize them by their letters, as one recognizes a species by its specific characters. Such a study is interesting but one docs not get much insight into the real Hamlet nor into the soul of Shakespeare in this way. But after the letters, words, and sentences have all been arranged in their proper paragraphs, scenes, and acts something altogether marvelous appears to grip the intellect and the imagination. The taxonomist has in the systematic study of the plant kingdom a problem comparable to a study of Shakespeare's Hamlet in all of its literary, artistic and scientific aspects. He deals with the individual plant and its characteristics, measuring, numbering, weighing and judging of qualities; for he knows that the ancient author of the apocryphal "Wisdom of Solomon" was correct when he wrote

[1]Papers from the Department of Botany, The Ohio State University, No. 357.

that all things are ordered in measure and number and weight. But the real taxonomic problem begins when the measuring and numbering and weighing are done. If interest in taxonomy is to be continued, the student must be shown that there is something beyond the mere measuring and weighing and numbering.

The most complex problem which can be presented to the reasoning human mind is this organic system of plants and animals which surrounds us on all sides. The taxonomist is from the very beginning confronted by a bewildering array of characters, potentialities, and reactions of different magnitudes and the first fundamental problem is to make an inventory of these characteristics by placing them into their proper categories. After taking a general survey of the situation, three general classes of characteristics or potentialities can be distinguished. First are the general fundamental potentialities which form an accumulation series from the level of the lowest bacteria to the level of the angiosperms, together with additional accumulative potentialities appearing in the distinct phyletic lines. Second are the great segregative potentialities, which establish the group limits of smaller and smaller extent from the distinctive phylum characters through the series of class, order, family and genus characters or of still smaller segregative groups. Third are the nearly endless numbers of small specific and varietal characters and their potentialities which are the genes or groups of genes and the changing of which through ordinary mutations does not affect the more fundamental group characteristics or even disturb to any extent the taxonomic position of the species. But the potentialities whether general or specific in nature, can only be inferred from a study of the characters developed through the physiological activity of the cells and tissues during growth and during the general ontogenetic cycle. It soon becomes evident that a given hereditary system will often not produce the same characters in one ecological environment as in another. Thus a plant of a given variety of hemp may come to maturity when 8 inches high, or it may not attain maturity until it is 8 feet or more in height. It may begin to bloom in 2 weeks after the seedling breaks through the ground or not until it has attained an age of 8 months. It may be pure in sex expression, either staminate or carpellate, or it may be a bisporangiate individual producing both stamens and carpels. In addition to the uncertainty

produced by fluctuation the systematist is still further troubled in the study of some groups by the easy hybridization of both near and distant types, so that what he may consider as a distinct species may fall to pieces in its very first reproductive phase.

The first problem then in making a study of phyletic groups, whether great or small, is to make an inventory of the general fundamental potentialities and reactions responsible for the accumulated characteristics evolved in the plant kingdom. The fundamental potentialities are those which have been accumulated in the general plant series and are apparently never lost and very rarely inhibited by inhibitative potentialities. In a few cases they may progress to a more advanced condition, however, through the greater perfection of the given reaction system. One can without a very minute study of characters and processes easily discover at least 100 such accumulated, general, fundamental potentialities, appearing in the seven successively higher divisions or subkingdoms of the living plants as follows:

1. Protophyta—18 accumulative fundamental potentialities.
2. Nematophyta—18 + 12 = 30.
3. Bryophyta—30 + 15 = 45.
4. Pteridophyta Homosporae—45 + 15 = 60
5. Pteridophyta Heterosporae—60 + 10 = 70.
6. Gymnospermae—70 + 15 = 85.
7. Angiospermae—85 + 15 = 100.

After such a general study, the problem must be restricted to the special subdivisions, to the segregative characters of the main phyletic groups; but each higher division is to be considered in relation to all the divisions in the general group until one has disposed of this group system as far as the genus. At this point the most important problem is reached. For the genus contributes part of the name of a plant and this is of fundamental concern to society in general, often much greater than to the systematic botanist himself. Because of this universal and practical aspect, the specialist should consider the effect of his work on society in general and not merely determine whether his segregations and lumpings seem reasonable to himself. In this respect phylogenetic thinking can aid decidedly in the establishment of rational genera. The question will then arise as to the harmoneous treatment of the particular

group in relation to the whole, and in relation to the segregations in other similar families. How shall any one decide what is a good and reasonable genus? Shall there be but a single distinctive character or shall there be a greater or smaller aggregate of characters considered in the establishment of a genus and what shall be the magnitude or importance of the characters? Is there not some way that we might come to a fairly scientific conception of the genus group, or must we be ever at the mercy of the genus "splitters" until every linneon becomes a "genus"? For example, it does not seem sensible to put the red maple and the silver maple into two genera. One shudders to think of the consequences if all genera were divided up to the same extent as Acer has been recently. But whatever the degree of splitting or lumping, it seems reasonable to segregate both genera and species on fewer and smaller characters in the lower plants than in the higher.

The phylogenetic viewpoint is also of very great importance in the segregation of species and in determining their relative positions in the genus. In a study of Equisetum, it becomes evident that the internodal ridge with a double row of tubercles or with a bicarinate condition has been attained independently in at least four distinct phyletic lines. So in a comparative study of *E. praealtum* Raf. and *E. hiemale* L. it becomes obvious that the simple internodal ridge of *E. praealtum* with a single line of tubercles is the more primitive condition. The internodal ridge of *E. hiemale* with a double row of tubercles indicates the addition of an important new progressive potentiality, and the plant is thus a distinct step in advance of *E. praealtum*. Both are good species but if one is to be regarded as a variety of the other the phylogenetic point of view will require that *E. hiemale* be considered a variety of *E. praealtum*.

The phylogenetic treatment of the species of a genus is a great aid in the study of geographic distribution. In the case of Equisetum there is quite a remarkable correspondence between the present geographic distribution of the species and the ascertained phylogenetic relation.

Because of a lack of knowledge of the general evolutionary sequence and because the whole grass series was topsy-turvy, with *Zea Mays* L. at the bottom instead of at the top where it belongs, there have been all sorts of odd hypotheses in relation to the nature and origin of this very important economic species. But when the grass series is put right side up, with the bamboos

at the bottom and Indian Corn at the top, the problem of relationship and origin takes on a very different aspect from what it had before.

Just as the grass series was entirely upside down so also was the Equisetum series in practically all modern treatments. These arrangements came down from botanists who neither believed in any evolutionary process nor had any definite conception of how to evaluate simple and complex reaction systems properly. Thus *E. arvense* L. was at the base of the series and when it was discovered that its gametophytes were more or less unisexual, the conclusion was immediately drawn that all Equiseta have unisexual gametophytes. But it has been found to be contrary to the facts. Now when the phyletic series is properly arranged, in accordance with both the evidence from paleobotany and the comparative study of the reaction systems of the living species, *E. arvense* comes out at the end of the line and its unisexuality appears as a final step leading toward the higher heterosporous level.

The same kind of taxonomic confusion arises when such a genus as Onoclea is placed at the base of the Polypodiaceae, as is still commonly the practice. When a comparative study of its potentialities is made, it stands out as one of the most complicated of ferns. Now just as in Equisetum, it is found that Onoclea has unisexual gametophytes and has thus advanced decidedly toward the condition of the heterosporous plants, a flat contradiction of its supposed position at the base of the Polypodiaceae.

When taxonomy is taught to the more advanced students from the phylogenetic point of view it never fails to arouse a most profound interest and curiosity. After all has been said, taxonomy is still the real study of plants. Taxonomy is the central ring of the main circus-tent of botany; other aspects of the subject are the side rings and the side shows. So whenever taxonomy is neglected botany must suffer severe loss in its standing as a fundamental science. It is therefore important that both those who practice taxonomy and those who teach it consider methods of procedure most carefully and hold fast that which is good.

SOME NEW SPECIES OF PARABOLOCRATUS (HOMOPTERA, CICADELLIDAE)

DWIGHT M. DE LONG
Ohio State University

Parabolocratus continuus n. sp.

Resembling *viridis* in general appearance but with ventral margin of male pygofer not notched. Length, ♂, 6 mm.

Vertex rounded at apex a little more than half as long as basal width between eyes, about three-fourths as long in male as pronotum. Face convexly rounded, not strongly inflated.

Color dull green tinged with brownish, a dark line just beneath margin of vertex.

Male valve short and broad, plates as long as combined basal width, concavely narrowed to rounded apices. Pygofers exceeding plates by one-third their length, ventral margins not notched, concavely rounded at apex to strongly produced dorso-caudal portion. Body of oedagus short, appearing very slender in ventral aspect. Broad in lateral view, not enlarged at apex, a lateral branch either side arising before apex.

Holotype male, Farewell Creek, Saskatchewan, Canada. Male paratypes, Yellowstone National Park, Wyoming, July 4, 1930.

Parabolocratus terminus n. sp.

Resembling *viridis* in size and form, but vertex shorter and male pygofers broad, rounded at apex. Length, ♂, 6 mm.

Vertex rather broadly rounded, about two-thirds as long as basal width between eyes, a little shorter in male than pronotum.

Color green washed with yellow, a black line below margin of vertex.

Male valve concealed, plates longer than combined basal width, tapered to bluntly pointed apices. Pygofers exceeding plates by one-third their length, apices broadly rounded, ventral caudal margin more roundedly produced, ventral margins without notch. Oedagus broad at base, tapered to a pair of apical processes. Dorsal portion bearing a broad, short tooth one-third the distance from base.

Holotype male, Capa, S. D., September 24, 1920 (Severin).

Parabolocratus inflatus n. sp.

Resembling *major* but vertex much shorter and with pygofers rounded apically and produced at middle caudally. Length, ♂, 5.5 mm.; ♀, 7.5 mm.

Vertex broadly rounded, about four-fifths as long as wide between eyes in male and as long as pronotum. Vertex concave, curved upward at apex, face strongly inflated. Elytra in female exposing last segment and ovipositor.

Color green washed with yellow, a dark brown line beneath margin of vertex.

Genitalia: Female last ventral segment roundedly produced. Male valve short, narrower than plates which are one-fifth longer than combined basal width, concavely tapered to pointed apices. Pygofers almost one-third longer than plates, apices roundedly produced at middle of caudal margin, ventral margin concavely rounded, not notched. Oedagus short, in lateral view broad, in ventral view slender, tapered with a process arising laterally either side just before apex.

Holotype male, allotype female and female paratypes, Yellowstone National Park, Wyoming, July 4, 1930 (DeLong); female paratypes Stanley Basin, Idaho, August 3, 1930 (DeLong).

Parabolocratus constrictus n. sp.

An elongate, narrow species resembling *flavidus*, but with vertex more produced, narrowed just before eyes and with apex rather broadly rounded. Length, ♀, 8 mm.

Vertex longer than width between eyes, concavely narrow just before eyes, apical half convexly rounded to broad, rounded apex; longer than pronotum, margin thin, face in profile slightly convex.

Color green tinged with yellow.

Genitalia: Female last ventral segment almost truncate with median fourth produced into a bluntly pointed tooth.

Holotype female and female paratypes, Miami, Florida, April 4 to 14, 1921 (DeLong).

This species can easily be separated by the elongated head and constricted vertex just before eyes.

Parabolocratus elongatus n. sp.

Form and general appearance of *grandis* but much longer with a longer vertex which is conspicuously convexly rounded between lateral margins; length, ♀, 10–11.5 mm.

Vertex one-fourth longer on middle than basal width between eyes, one-half longer than pronotum, convexly rounded on dorsal surface. Elytra short, exposing the last four or five abdominal segments. Face rather strongly inflated.

Color yellowish tinged with green, veins of elytra green.

Genitalia: Female last ventral segment roundedly produced.

Holotype female and paratype female, Interior, S. D., August 28, 1922 (Severin); paratype female, Martin, S. D., September 3, 1923 (Severin).

This is the largest species of the genus which has been described to date and can be distinguished from most of the other species by the very short elytra.

Parabolocratus rotundus n. sp.

Resembling *major* in form and appearance but with a broadly rounded male pygofer. Length, ♂, 7 mm.

Male vertex one-half wider than median length, a little longer than pronotum. Elytra exposing only the pygofers of the abdomen. Face strongly inflated.

Color greenish without definite markings.

Genitalia: Male plates about one-half longer than combined basal width, not quite as long as pygofers which are broadly rounded posteriorly and without a preapical notch on ventral margin. Oedagus stout, in lateral view decidedly narrowed before apex which is expanded and bears a rather long stout lateral process on either side of expanded portion before apex.

The rounded pygofers will immediately separate it from any other species of the genus.

Holotype male, Madison, Wisconsin, September 2, 1916 (DeLong). Paratype males same locality and date, Castalia, Ohio, July 28, 1917 (DeLong); Beach, Illinois, August 7, 1935 (DeLong and Ross); Beach, Illinois, July 25, 1934 (Frison and DeLong) and Des Plaines, Illinois, September 18, 1935 (DeLong and Ross).

How a Physicist Thinks

During recent years, there has been considerable discussion of philosophical questions raised by the new physics, particularly in its statistical, quantum, and relativistic aspects. Both physicists and philosophers have had their say, and considerable diversity of opinion exists. The book "On Understanding Physics," by W. H. Watson, Assistant Professor of Physics at McGill University, is an important contribution toward clear thinking on "natural philosophy." A few sentences from the introduction and the first chapter will serve to indicate Watson's approach.

"In maintaining that it is necessary . . . to show the limits of achievement to be expected in philosophy, one is certain to incur reproof at the hands of not a few professional philosophers. It may seem an impertinence on my part to write boldly on matters which some of my philosophical friends wish to preserve intact in their traditional muddle. The great philosophers of the past . . . would be appalled at the thought that they had produced an indestructible cud for academic rumination." "The primary concern of philosophy is with the logic of ordinary language. . . . Perhaps the most important function of the philosopher in science is to remove the difficulties of the learner, either of entirely new theory or of the older parts of the subject which often present so many puzzles to teacher and student. In this connection he can do good work by discrediting ingenious but unnecessary theories which are designed by their authors to surmount contradictions and serve merely to hide confusion of thought by their very cleverness." "Problems set by a sense of unclearness are not solved, but removed when the source of confusion of thought has been discovered." "Authority in philosophy is the authority of clear statement as opposed to muddled statement, of clear thought as opposed to intellectual puzzle."

Although this book is intended primarily for readers familiar with physics, the discussion should prove illuminating to scientists in general. The few technical details of physics to which the author refers are used simply as illustrations. This book is not light reading—no penetrating discussion of fundamental problems can be—but the author's lively style and his intolerance of nonsense reward the reader with frequent flashes of insight.—*Harold P. Knauss.*

On Understanding Physics, by W. H. Watson. xii + 146 pp. London, Cambridge University Press; in New York, The Macmillan Co., 1938.

NEW TEXAN FULGORIDAE[1] (HOMOPTERA)

JOHN S. CALDWELL
Ohio State University

Cixius chisosus n. sp.

Length 6 mm. Resembling *apicatus* Fowler in form, marking, and coloration of elytra but with vertex extending beyond the eyes as in *flavo-brunneus*.

Vertex deeply excavate caudad, obtusely angled cephalad, less than twice as wide as median length. Face in profile evenly convex. Male pygofers with deep narrow opening; median projection short, pointed. Styles slender throughout, appearing as high-heeled rather long-toed boots. Dorsal membrane long, narrow, recurved into a broadened scoop.

Pale tawny throughout. Elytra not banded but with apices brokenly and heavily darkened.

Male holotype, Chisos Mts., Texas, VII–9–36.

Cixius knulli n. sp.

Length of male, 5.5 mm.; female, 6.2 mm. Resembling *chisosus* except for darker appearance and banded elytra.

Male pygofers with shallower notch than *chisosus* and the sides more oblique; median projection short, rounded. Styles excavate basally with broad projections meeting at midlength; the apices broad, flexed outward, slightly recurved. Dorsal membrane extremely long, narrow, scarcely broadened apically with the apex reflexed. Female ovipositor long and slender.

Head and body tawny. Elytra yellowish with a broad transverse band basally and across the middle; apices extremely and solidly darkened.

Male holotype, female allotype, and paratypes from Davis Mts., Texas, VIII–21–36 and one paratype, VI–2–37.

The writer names this species in honor of his friend, Dr. Josef N. Knull.

Oliarus nigravittus n. sp.

Length 8 mm.; width 3 mm. Resembling *sonoitus* Ball in size and form but lighter in general color and the elytra has a longitudinal stripe.

Vertex as broad as long; median carina present for full length. Face light brown; profile more curved than *aridus* Ball.

Male pygofers deeply and broadly notched, truncate laterally; median projection with slender apex. Styles of same form and appearance as in *pima* Kirk.

---

[1]Types are in the Ohio State Collection. All 1936 material was collected by Dr. J. N. Knull, and the 1937 material by both Dr. and Mrs. Knull

Vertex, face, and median tablet of mesonotum tawny, rest of body blackish. Elytra milky with a sub-basal, narrow, black band not reaching costal margin but continued very narrowly caudad along commissural margin and terminating at the anal vein. Cross veins and furcation of longitudinal veins with black spots.

Male holotype, Uvalde, Texas, VIII–4–37. Paratype, V–23–35.

Oliarus lobatus n. sp.

Length of male, 7 mm.; female, 8.2 mm. Somewhat resembling *pima* Kirk in general appearance.

Vertex longer than broad; lateral margins elevated; median carina present for basal third; caudal margin deeply notched. Frons much narrowed between eyes, about equal in length to clypeus. Mesonotum distinctly five carinae.

Male pygofers evenly, obliquely truncate laterally; ventral opening deep, broad; median projection long, broad, suddenly narrowed apically. Styles much longer than pygofers; apical portion greatly enlarged producing a large, flat, lateral lobe. Dorsal membrane broadly notched apically with a pointed projection on either side of notch.

General color blackish fuscous. Frons darker than clypeus. Forewing whitish-hyaline in both sexes; black punctations on veins very large; infuscation of cross-veins in female very broad, sometimes fused together.

Male holotype, Davis Mts., Texas, VIII–36; female allotype, Davis Mts., Texas, VI–36; paratypes, Davis Mts., Texas, and Hauchauca Mts., Ariz., 1936 and 1937.

Oecleus bilineatus n. sp.

Length of male, 4.5 mm.; female, 5 mm. Resembling *decens* Stål by having the vertex closed caudad and approaching *campestris* Ball in cephalic width of vertex but differing from both in elytra structure and color and in having the mesonotum black with two yellow stripes.

Vertex triangular, exceeding eyes by half its width; in profile about right angled with face which is angled in front of the eyes. Elytra appearing long, narrow, hyaline; commissure twice interrupted with black; veins dark brown, darkening apically, feebly pustulate; costal vein scarcely thickened; nodal cell at least twice as long as broad.

Black throughout; carinae of front, vertex, and pronotum light; mesonotum with intermediate carinae straw yellow.

Female holotype and paratype, and male allotype from Davis Mts., Texas, VII–6–36.

Acanalonia hadesensis n. sp.

Length of male, 3.9 mm.; female, 4.7 mm.; forewing of male, 3.5 mm.; female, 4.4 mm.; width of forewing of male, 2.6 mm.; female, 3.2 mm.

Head scarcely produced beyond eyes; vertex equal to or less than length of pronotum, caudal margin concave, lateral margins slightly divergent; front upright with lateral margins gently bulged basally, median carina prominent. Forewing with costal margin strongly

rounded, apical margin gently convex; reticulations scarcely visible; longitudinal veins with few branches. Last ventral segment of female with a deep, broad, semicircular notch.

Head, thorax, legs, and abdomen straw yellow; forewings pale green deepening in color apically.

Female holotype, male allotype, Devil's River, Texas, VII-2-36.

Flatoides fecalfuscus n. sp.

Length of male, 10 mm.; female, 11 mm. Slightly darker in appearance than *fuscus* Van Duzee and differentiated by the presence of a single preapical spine on the hind tibiae.

Vertex broader than long, rounded cephalad. Frons emarginate apically. Clypeus little longer than broad, flat. First and second antennal segments about equal. Hind tibiae with one spine before apex.

Last ventral segment of male broadly but shallowly excavate caudad. Styles contacting for basal third thence divergent to apex, these margins gently sinuate; apices each with one large spine projecting inward; whole style much shorter than in *fuscus*. Dorsal membrane long, narrow, recurved.

Female with last and penultimate segments deeply and almost squarely notched. Pygofers short, broadly rounded, with heavy teeth. Anal segment long, very broad.

Dirty grey throughout with vein darkening to blackish.

Male holotype, Davis Mts., Texas, VIII–2–37; female allotype, Davis Mts., Texas, VI–14–36, and paratypes from the Davis and Chisos Mts., Texas, and Hauchauca Mts., Arizona.

An Intimate Glimpse of a Naturalist

Edward Wilson is probably best known to people in this country as a South Polar explorer, one of the outstanding men in the expeditions led by Captain Scott. This book tells not only of his two expeditions to the South Pole with Captain Scott, but also of his earlier life.

The character and ability of Wilson are well summed up by one of his friends (p. 213): "Here was an artist of first-rate ability as to technique, who drew only truth, and refused to let his imagination guide his pencil. . . . He was a passionate lover of birds, yet could steel himself to kill them for his scientific work. He was deeply religious, yet had the rare ability to keep his religion out of sight; ceaselessly at work himself, he did not demand an equal energy from his fellows. One had glimpses in him . of the missionary yet without that arrogance which presumes to teach others."

This book is made up largely of Wilson's diaries, letters, and notes, and of comments about him by his friends. It is illustrated with 17 color plates and 50 drawings in black and white, covering a variety of subjects, all by Wilson. The twelve chapters cover his life from his first diaries, his life in medical school, his travels in Norway and Switzerland, his work in England, and his two South Polar expeditions.

The book gives a vivid impression of this charming and versatile naturalist. The chapters on the polar expeditions are particularly fascinating. The book is interesting, informative, and inspirational, and should appeal to anyone interested in the biographies of naturalists.—*D. J. Borror.*

Edward Wilson: Nature Lover, by George Seaver. xi+221 pp New York, E. P. Dutton & Co., Inc. $3.00.

ADDITIONS TO THE OHIO LIST OF DRAGONFLIES (ODONATA)

DONALD J. BORROR
Department of Zoology and Entomology,
Ohio State University, Columbus, Ohio

In my annotated list of the dragonflies of Ohio[1] 127 species were recorded. During 1937 two species not previously recorded for the state were collected, bringing the total to 129. These two species are as follows:

128. *Macromia pacifica* Hagen. 1 ♀, August 9, 1937, J. Fred Williams. This specimen was taken from the radiator of an automobile, which had picked it up while going from Indian Lake to Columbus. This insect was probably picked up by the automobile in Logan County. This species is primarily a western species, but has been reported as far east as Indiana.

129. *Enallagma basidens* Calvert. 7 ♂ and 4 ♀, June 26, 1937, and 2 ♂, May 30, 1938, by D. J. Borror, at a gravel pit pool about two miles southeast of Germantown, in Montgomery County; 16 ♂ and 15 ♀, August 21, 1937, by D. J. Borror, at a gravel pit pool about one mile north of Miamiville, in Clermont County. It is of considerable interest that this species should be taken in southwestern Ohio, as it was described from Texas and up until a few years ago was known only from the southwestern part of the United States. In 1929 Mr. B. Elwood Montgomery took it in Indiana,[2] and he reports[3] that since then it has become more abundant in Indiana. It appears that this species is extending its range northward and eastward.

Since the publication of my annotated list of Ohio dragonflies, a number of new county records have been obtained which extend our knowledge of the distribution of dragonflies in the state. These records are based primarily on the results of five collecting trips: to Hocking Co., June 6, 1937, by Dale W. Jenkins and the writer; to Licking, Coshocton, Tuscarawas, Wayne, and Ashland counties, June 13–15, 1937, by Dale W. Jenkins and the writer; to Montgomery, Warren, and Butler counties, June 26, 1937, by R. Henry Kyle and the writer; to Fayette, Clinton, Brown, Clermont, and Butler counties,

[1]Borror, Donald J. 1937. An annotated list of the dragonflies (Odonata) of Ohio. Ohio Jour. Sci., 37 (3): 185–196.

[2]Montgomery, B. Elwood. 1932. Records of Indiana dragonflies, VI, 1931. Proc. Ind. Acad. Sci., 41: 449–454.

[3]*Id., op. cit.*, 43: 215, 1934; 44: 233, 1935; 46: 207, 1937.

August 21, 1937, by W. Donald Murray and the writer; and to Montgomery Co., May 30, 1938, by R. Henry Kyle and the writer. All material collected on these trips is in the writer's collection.

The sources of the new records obtained other than on the above trips are indicated in each case. The following abbreviations are used: BJ, collected by Dale W. Jenkins and the writer and in the writer's collection; DJB, collected by the writer and in his collection; DWJ, collected by Dale W. Jenkins and in the writer's collection; OES, in the collection of the Ohio Agricultural Experiment Station at Wooster; VEG, collected by Vernon E. Gifford and in his collection. County records in *italics* are based on sight only, with no specimens collected.

The new county records are as follows (the species are numbered as in my 1937 annotated list):

2. *Gomphoides obscura* (Rambur).[4] Hocking.
9. *Gomphus* (*Gomphus*) *exilis* Selys. Wayne (OES).
10. *G.* (*Gomphurus*) *fraternus* (Say). Wayne (OES).
14. *G.* (*Gomphus*) *lividus* Selys. Franklin (BJ), Wayne.
18. *G.* (*Gomphus*) *spicatus* Hagen. Ashland. This record extends the latest date for the capture of the species in Ohio to June 15.
22. *G.* (*Arigomphus*) *villosipes* Selys. Wayne (OES).
24. *Dromogomphus spinosus* Selys. Delaware (BJ).
28. *Basiaeschna janata* (Say). Wayne. This record extends the latest date for the capture of the species in Ohio to June 15.
31. *Anax junius* (Drury). Ashland, Butler, Clermont.
34. *Epiaeschna heros* (Fabricius). Wayne (OES).
36. *Aeshna constricta* Say. Wayne (OES).
38. *A. umbrosa* Walker. Cuyahoga (VEG).
43. *Cordulegaster obliquus* (Say). Hocking, Jackson (DWJ). May 22 to July 15.
44. *Macromia illinoiensis* Walsh. *Licking*.
49. *Epicordulia princeps* (Hagen). Ashland, *Clermont*, *Clinton*, *Montgomery*, Wayne (OES).
50. *Tetragoneuria cynosura* (Say). Ashland, Coshocton, Hocking, Wayne.
54. *Perithemis tenera* (Say). *Butler*, *Clermont*, *Montgomery*, Wayne, (OES).
55. *Celithemis elisa* (Hagen). Clermont, *Montgomery*, Wayne (OES). The Clermont Co. record extends the latest date for the capture of the species in Ohio to August 21.
56. *Celithemis eponina* (Drury). *Clermont*. This record extends the latest date for the occurrence of the species in Ohio to August 21.

[4]This species was erroneously placed in the genus *Negomphoides* in my 1937 list.

62. *Libellula* (*Holotania*) *cyanea* Fabricius. Perry (in the collection of the Ohio State University).

64. *L.* (*H.*) *luctuosa* Burmeister. Ashland, *Butler*, Clermont, Clinton, *Hocking*, Montgomery, Wayne (OES).

65. *L.* (*Plathemis*) *lydia* Drury. Ashland, *Butler*, Wayne.

66. *L.* (*Neotetrum*) *pulchella* Drury. Ashland, Butler, Clermont, *Montgomery*.

68. *L.* (*Eolibellula*) *semifasciata* Burmeister. Wayne.

70. *Sympetrum ambiguum* (Rambur). Butler, Clinton.

73. *S. rubicundulum* (Say). Butler, Montgomery, Wayne (OES). The Montgomery Co. record extends the earliest date for the capture of the species in Ohio to May 30.

78. *Pachydiplax longipennis* (Burmeister). Ashland, Butler, Montgomery, Wayne (OES).

79. *Erythemis simplicicollis* (Say). Ashland, Clermont, Clinton, Fayette, *Montgomery*, Wayne (OES).

80. *Pantala flavescens* (Fabricius). Cuyahoga (VEG).

82. *Trapezostigma carolina* (Linnaeus).[5] *Montgomery*.

83. *Trapezostigma lacerata* (Hagen).[5] *Butler*, Clermont, *Hocking*, *Montgomery*, *Wayne*.

87. *Calopteryx maculatum* (Beauvais). Brown, Butler, Huron (OES), Montgomery, Warren. The Brown Co. record extends the latest date for the capture of the species in Ohio to August 21.

88. *Hetaerina americana* (Fabricius). Brown, Clermont, Montgomery, Warren, Wayne (OES).

95. *Lestes inaequalis* Walsh. Ashland.

96. *L. rectangularis* Say. Ashland, Butler, Clinton, Fayette, Hocking, Montgomery, Tuscarawas, Wayne (OES).

97. *L. uncatus* Kirby. Ashland, Wayne.

98. *L. unguiculatus* Hagen. Butler, Lucas (collected by Joe Bailey, and in the collection of the Museum of Zoology at Ann Arbor), Wayne (OES).

100. *Argia apicalis* (Say). Clermont, Fayette, Tuscarawas, Warren.

102. *A. moesta* (Hagen). Brown, Clermont, Montgomery, Vinton (DJB), Warren.

103. *A. sedula* (Hagen). Brown, Clermont.

104. *A. tibialis* (Rambur). Coshocton, Tuscarawas, Wayne.

105. *A. violacea* (Hagen). Butler, Clermont, Montgomery, Warren.

109. *Chromagrion conditum* (Hagen). Hocking.

110. *Enallagma antennatum* (Say). Montgomery.

113. *E. carunculatum* Morse. Wayne (OES).

114. *E. civile* (Hagen). Clermont, Montgomery.

118. *E. exsulans* (Hagen). Brown, Clermont, Coshocton, Warren, Wayne.

119. *E. geminatum* Kellicott. Ashland, Clermont, Montgomery.

120. *E. hageni* (Walsh). Ashland.

---

[5]Cowley, J. 1935. Nomenclature of Odonata: three generic names of Hagen. The Entomologist, 68: 283–284. According to Cowley, the genus *Tramea* Hagen, 1861, must be replaced by *Trapezostigma* Hagen, 1849.

121. *E. signatum* (Hagen). Ashland, Clermont, Montgomery, Wayne (OES).

123. *E. vesperum* Calvert. Ashland.

124. *Ischnura posita* (Hagen). Ashland.

126. *I. verticalis* (Say). Ashland, Brown, Clermont, Montgomery, Warren.

127. *Anomalagrion hastatum* (Say). Montgomery.

The Physical Universe

Man's Physical Universe, by Arthur Talbot Bawden, is a book which has been prepared as a text for survey courses in physical sciences. How well this problem has been coped with can perhaps best be determined by actual use of the book in such a course, but in this reviewer's opinion the problem still remains unsolved. Certain chapters of this book may be regarded as suitable for a course in high school general science, but for students of college calibre it would seem to constitute a waste of valuable time. A great many inaccuracies may be pointed out throughout the book; for example, on page 62, Yerkes Observatory is placed at Madison Bay rather than at Williams Bay where it is actually located; on page 150 Leyden, a Dutch city of 70,000 population, is depicted as an obscure German village. On page 424, in fig. 245, is shown how parallel beams of light are acted upon by convex and concave lenses. No discussion whatever follows concerning the points to which the light converges in the first case nor the point from which the light appears to diverge in the second case. The infra-red rays of the spectrum are discussed on page 443 and one is left with the impression that it is just another region of the spectrum where special photographic plates are required, whereas what is actually the case is that only a very narrow region is photographable (from $.8\mu$ to 1.1μ) while the remaining region (from 1.1μ to 300μ) must be investigated bolometrically. On page 605 occurs a discussion of quantum theory. The word formulas has been used instead of what probably should have been formalism. Werner Heisenber is portrayed as an abstract mathematician rather than a cracking good physicist and finally Schrödinger theory is represented as a manifestation of the theory of relativity—both statements are notoriously incorrect. One is indeed left with the impression that the author is poorly informed concerning his subject matter. The book can really not be recommended for the purpose for which it is intended.

—*H. H. Nielsen.*

Man's Physical Universe, by Arthur Talbot Bawden. xvii+812 pp. New York, The Macmillan Co., 1937. $3.50.

The Mathematics of Einstein's Theory of Gravitation

When Einstein developed his relativity theory of gravitation, he found the necessary mathematics ready to hand in Riemann's geometry. This geometry was a direct extension of the differential geometry of curves and surfaces in three-dimensional space to an arbitrarily curved space with any number of dimensions. The extension of the notations and methods of vector analysis to Riemannian geometry gave the tensor notation and absolute differential calculus of Ricci and Levi-Civita. In fact the paths of particles in Einstein's theory are lines of stationary length in a four-dimensional space-time homogeneous with respect to the Ricci tensor. Weatherburn's book is an introduction both to the tensor calculus and to Riemannian geometry. It is written in the same clear style as his books on vector analysis and differential geometry, and will form an admirable introduction either to advanced differential geometry or to the theory of relativity.—*L. H. Thomas.*

An Introduction to Riemannian Geometry and the Tensor Calculus, by C. E. Weatherburn. xii+191 pp. Cambridge, at The University Press; New York, The Macmillan Company, 1938. $3.75.

SPIDERS AND INSECTS FOUND ASSOCIATED WITH SWEET CORN, WITH NOTES ON THE FOOD AND HABITS OF SOME SPECIES

II. Ephemerida, Lepidoptera, Neuroptera, Odonata, Orthoptera, Thysanoptera, and Trichoptera

RAY THOMAS EVERLY
Holmesville, Ohio

EPHEMERIDA

This order is represented by only one species, unquestionably a visitor brought into the field by winds from the direction of the lake.

Ephemeridae

Hexagenia bilineata Say. Three specimens taken July 16 to August 8.
This is the species common along Lake Erie and known to the residents of this region as "June-bugs" or "Canadian Soldiers." One old gentleman of this locality advanced the naive suggestion that this insect "hatched from infertile fish eggs" During the summer months, when the wind is blowing off the lake, these insects are present in such numbers as to make driving extremely hazardous. Street lamps and lighted windows may be completely covered with a layer of these insects, and lighted advertisements will be entirely hidden.
Determination of these specimens was made by Mr. A. N. Caudell.

LEPIDOPTERA

This order is quite well represented. However, as many of the adults were difficult to capture, with time and proper collecting equipment, the number of species in this order could have been greatly extended. Determinations were made by Mr. F. H. Benjamin, Mr. August Busck, Mr. C. Heinrich, and Mr. John Thomas.

Arctiidae

Diacrisia virginica Fab. Two larvae taken on the corn plants July 10 and 12.

Estigmene acraea Dru. One adult taken August 12, and a larva taken on the corn plants July 29.

Geometridae

Geometridae sp. Four larvae taken on the corn plants in late August.

Pleuroprucha insularia Gn. Two adults taken August 1 and 12.

Gelechidae

Aristotelia (*Chrysopora*) *hermanella* Fabr. Two adults taken July 13 and 17.

Hesperidae

Pholisera catullus (Fabr.). One adult taken July 20.

Talides themistocles (Lat.). One adult taken August 5.

Lymnadidae

Anosia plexippus L. Observed resting upon a corn plant on July 16.
The presence of this species in the corn field was undoubtedly due to the milkweed present in the field. Larvae of this species were often observed feeding upon the leaves of milkweed.

Noctuidae

Acronycta oblinita (S. & A.). A larvae taken upon the corn plant in late August.

Caenurgia erecta Gr. Adult taken on July 15.

Ceramica picta Harris. "A pale larvae" taken on corn plant on July 17.

Heliothis obsoleta Fab. Adults taken on August 3, larvae on leaves of corn in late August.
The adults of this species were first observed flying in large numbers on August 5 among the corn plants when disturbed. The larvae were numerous in the ears of late sweet corn.

Lithacodia carneola Gn. One adult taken on July 31.

Noctuidae sp. Two larvae taken July 9 and August 2, and one pupae taken in late August.

Noctuidae (*Cirphus* group). One larvae taken upon the corn plant August 15.

Plusia sp. One larva and a cocoon and pupa taken on the corn plant in late August.
A larva of this genus was taken as the prey of *Sphex urnarius* (Daml.), (Hymenoptera-Sphecidae).

Prodenia sp. Early stage larva taken upon the corn plant July 10.

Prodenia ornithogalli Gn. One larva taken upon the corn plant in late August.

Nymphalidae

Basilarchia astyanax Fab. Observed resting upon the corn plants on July 5 and August 5.

Basilarchia disippus Godart. Observed flying in the field on July 8.

Polygonia interrogationis Fabr. Adult taken on August 6.
Other specimens of the genus were observed flying among the corn plants throughout the season, but it is impossible to state whether or not they were the same species.

Vanessa altanta L. One adult taken on August 9. Observed feeding upon the exudations from a corn borer opening on August 9. The species was a frequent visitor among the corn.

Vanessa cardui L. Adult taken on August 8. Pupa collected on corn plant in late August.

Vanessa virginiensis Dru. One adult taken on August 14.

Pieridae

Pieris rapae L. One adult taken July 20.

This species was common throughout the season, undoubtedly due to the fact that most of the cabbage fields in the near vicinity were unharvested due to prevailing low prices. The butterflies were so numerous about the cabbage fields that the air above had the appearance of a snow storm.

Pyralidae

Pyralidae sp. (*Pyraustinae*). One larva taken upon the corn in late August.

Argyria nivalis Dru. One adult taken July 13.

Nomophila noctuella D. & S. One adult taken July 20.

Pyrausta nubilalis Hbn.

The adults of this species were observed in the field in numbers from July 7 to 18, and again in much smaller numbers on August 10. A pupa was found during the dissections, on August 2 and two more were found on August 5. Two larvae were taken, one as the prey of *Glischrochilus quadrisignatus* Say (Coleoptera-Nitidulidae), on July 25. This larva was still partly in a tunnel. The other larva was being dragged away by an individual of the species *Prenolepis imparis* (Say), (Hymenoptera-Formicidae).

Loxostege similalis Gn. One adult taken August 12.

Tortricidae

Grapholitha interstinctiana Clem. One adult taken August 12.

Yponomeutidae

Glyphipteryx impigritella Clem. One adult taken July 28.

NEUROPTERA

Chrysopidae

These insects were very numerous in the corn field. Their stalked eggs were observed upon the corn plants throughout the season. Mr. Ralph Mathes reported observing an undetermined larva feeding upon a corn borer egg mass upon a corn leaf. Determinations of the following species were made by Mr. A. N. Caudell.

Chrysopa chi Fitch. Five specimens taken July 9 to August 8.

Chrysopa chlorophana Burm. One specimen taken August 8.

Chrysopa ploribunda Fitch. Three specimens taken July 29 to August 7.

Myrmeleontidae

Adults of this family were observed frequently during the season. Even though not strong flyers, they were difficult of approach and only one specimen was taken. This was determined by Mr. A. N. Caudell.

Clathroneuria sp. One specimen taken July 18.

ODONATA

Ischuridae

Several species of this group were observed in the field at different times during the season, but only one specimen was captured. Mr. D. A. Borer made the determination.

Ischnura verticalis Say. One female taken upon the corn plant on August 8.

Libuellidae

No specimens of this family were collected, as they are exceptionally alert and fast on the wing. They were observed throughout the season flying and feeding above the corn, and were seen occasionally to rest upon the tassels and upper leaves of the corn plants.

ORTHOPTERA

This order was represented in the corn field chiefly by the grasshoppers and crickets. None were observed feeding upon the corn plants, although many were frequently seen resting upon the corn leaves. All determinations were made by Mr. E. S. Thomas.

Acrididae

Dissoteria carolina (L.). One male taken on July 25 and two females taken July 29 and August 3. A III instar nymph was taken July 9.

The above species was very abundant on the ground of the roadways between the plots of corn and were observed occasionally among the corn plants. The first adults were seen on July 18 and were very common by July 26. On July 29 two specimens, the sex unknown, were observed to alight beside each other facing in opposite directions. After a few moments they simultaneously raised their posterior pairs of legs into the air four times, very slowly, the angle formed by the femur and tibia while at rest, was retained when the legs were raised. They then flew in opposite directions.

Melanoplus femur-rubrum (DeG.). IV instar male taken August 7.

Melanoplus mexicanus mexicanus (Saus.). Two females taken July 11 and 18, a V instar male taken July 9, and a V instar female taken July 31.

Blattidae

Parcoblatta uhleriana (Saus.). One adult female taken on the corn plant July 22.

Gryllidae

Gryllus assimilis Fab. Four adult females taken July 17 to late August. One V instar female collected in late August.

Nemobius fasciatus subsp.? (DeG.). One pair taken August 5 and 14, a V instar male on August 1, a III instar nymph on August 14, and a III instar female taken July 31.

The specimens of the two above species were very common on the ground beneath corn and weed debris.

Oecanthus nigricornis nigricornis F. Walker. One adult female taken August 14 and a III instar male taken July 17.

Tettigonidae

Conocephalus fasciatus subsp.? (DeG.). One male, "undoubtedly a migrant," taken on August 7.

Orchelium vulgare Harris. V instar male taken July 28, IV instar male July 16, and IV instar female on July 19.

THYSANOPTERA

Two families of this order were collected in the cornfield. Determinations were made by Mr. Dudley Moulton.

Aeleothripidae

Aeliothrips sp. One specimen taken July 11 on the corn plant.

Thripidae

Anaphothrips striatus Osb. The "oat-bug" was very abundant about the time the oats in adjoining fields were cut, and were very annoying and irritating when crawling upon a person's skin.

TRICHOPTERA

This order was represented by one small specimen which Mr. A. N. Caudell stated "a small caddis-fly. I am unable to name this."

Bird Flocks and the Breeding Cycle

The author spent two years on Priest Island, off the northwest coast of Scotland, studying social behavior in breeding flocks of gulls and other sea birds. This book is a report of his observations, primarily as they relate to the theory that the gregarious habit in these birds has an important influence on their mating and nesting activities.

While the onset of the reproductive condition in birds is influenced to a considerable extent by external physical factors and inherent reproductive rhythms, the author contends that the final steps in the reproductive cycle, mating and nesting, are in these gregarious birds definitely influenced by the contacts of the individual bird with others. These contacts in the case of gulls are described in considerable detail. The author shows that in many species of birds there is a minimum population density for reproductive activities, below which reproduction will not take place.

The chapter headings are indicative of the scope of the book: I, Sexual Periodicity; II and III, Breeding Flocks of Gulls; IV, Communal Courtship; V, Conclusion; Appendix, List of Types of Display in Gulls.

This book should be of interest not only to anyone interested in birds but to anyone interested in animal sociology or in the factors affecting the reproductive cycle. The American bird student need not worry about the interest of the book because it concerns British species; the same or closely related species occur along the American coasts, and their social behavior is undoubtedly very similar to that of the species described. The author of this book has made a definite contribution to our knowledge of avian sociology and physiology, which should stimulate further observations along similar lines.—*D. J. Borror.*

Bird Flocks and the Breeding Cycle. A contribution to the study of avian sociality, by F. Fraser Darling. Cambridge, at the University Press; New York, The Macmillan Co., 1938. $1.75.

THE ANATOMY AND HISTOLOGY OF THE ALIMENTARY SYSTEM OF THE HARLEQUIN CABBAGE BUG, MURGANTIA HISTRIONICA HAHN. (HEMIPTERA, PENTATOMIDAE)[1]

C. S. HARRIS[2]
Shell Petroleum Corporation,
Wood River, Ill.

The Harlequin cabbage bug, *Murgantia histrionica* Hahn, is a common and frequently very destructive pest of cruciferous plants in the southern part of the United States and south at least as far as Central America. Although it occurs, occasionally, as far north as the Canadian shores of Lake Erie, it is apparently unable to withstand ordinary winters in latitudes much farther north than the fortieth parallel (22)[3] but is thought to migrate north from its overwintering habitats each season.

METHODS

Specimens used in studies of the gross anatomy of the alimentary system were dissected *in vitro* under 1-normal saline solution and inasmuch as material was abundant specimens so used were discarded.

Tissues to be used for histological preparations were taken both from fresh material and from preserved specimens. Both methods proved satisfactory. The preservative or fixative, in all cases, was Kahle's solution (14). All histological preparations were made by the paraffin method and cut on a rotary microtome. The various structures were sectioned individually and in addition several series of sections were cut, in different planes, from the viscera *in toto* and still others from entire individuals, taken and preserved in the teneral condition. The method described by Awati (1) for softening hardened, chitinized structures was not discovered by the writer in time for use in this study.

---

[1]Contribution from the Department of Zoology and Entomology of the Ohio State University, Number 113.

[2]The writer wishes to express his appreciation to Dr. C. H. Kennedy for his criticisms and suggestions during the course of this study and also to those of his colleagues who aided in securing material and in various other ways.

[3]Numbers in parentheses refer to the bibliography, page 324.

Haemalum was used as a nuclear stain and Fast Green, F. C. F. for cell walls and cytoplasm. Cell walls were not uniformly well stained and it is recommended that other stain combinations be added or that, if possible, a triple staining technique be used to obviate this deficiency.

Drawings, with the exception of Figures 1 and 2, were made with the aid of a projection microscope, the finer details being filled in, freehand, during observation of the tissues under high power or oil immersion objectives.

GROSS ANATOMY OF THE ALIMENTARY CANAL

At least nine distinct regions are recognizable in the alimentary canal. Three are stomodeal, three ventricular and three proctodeal. It will be noted that in this, as in many phytophagous species of Hemiptera, the ventriculus comprises by far the largest part of the alimentary canal.

THE STOMODAEUM

The *functional mouth* is a short, curved, chitinous tube, lying in the extreme anterior portion of the head capsule and opening, at its posterior end, into the *cibarium* or sucking pump. The cibarium extends nearly to the posterior margin of the head capsule, giving way, posteriad of the brain, to the *oesophagus* which extends just into the thorax (Fig. 2, Oes). In cross-section the cibarium (Fig. 3) appears V-shaped, is firmly embedded in the hypopharynx and the various parts of the tentorium and is connected to the dorsal wall of the head by its dilator muscles.

Both the functional mouth and the cibarium are preoral structures. Various authors have referred to the cibarium as the pharynx but Weber (29) and Snodgrass (28) point out that the true pharynx lies posterior to the sucking pump. In the present species the pharynx is almost obliterated and the extreme modification of the parts makes it impossible to limit, precisely, the various preoral and stomodeal structures.

THE VENTRICULUS

The first stomach or *anterior portion of the ventriculus* (Fig. 2, 1 Vent) is thin walled and of comparatively large diameter. It bears a prominent, dorsal, median raphe, several irregular lateral folds, but no ventral raphe. During the dissection of the insect *in vitro*, peristaltic waves were frequently observed in this region. The second stomach or *mesial portion of the ventriculus* (Fig. 2, 2 Vent) is a smooth walled tube, dilated, in active specimens, near its posterior end, to form what may be a storage space somewhat analagous to the crop of other insects. In hibernating specimens this dilatation was much less pronounced and in contrast to that of active specimens contained little or no food residue. Histological examination indicates that it should not be considered a separate division of the ventriculus. The third stomach or

posterior portion of the ventriculus (Fig. 2, 3 Vent) is remarkable in that it bears four rows of rather disc-like caeca. These will be more fully discussed in connection with their histology.

THE PROCTODAEUM

The proctodaeum, like the stomodaeum, is very short. It consists of a small caliber *anterior intestine* (Fig. 1, Ant Int), a large, thin walled *posterior intestine* (Fig. 2, Rect Sac) or rectal sac and a narrow *anal canal*, (Fig. 14) the latter contained within the anal capsule. During dissection the posterior intestine was occasionally observed to contract suddenly, as if expelling its clear, liquid contents, following which action it slowly regained its former, distended appearance.

Arising from the ventral wall of the anterior intestine is a pouch (Fig. 1, Fig. 2, Ileum?) into which the four Malpighian tubules empty. Breakey (7) reports two such diverticula in *Anasa tristis*, with two Malpighian tubules emptying into each one and various similar structures are found in other Hemiptera. Bearing in mind that in most insects the Malpighian tubules empty directly into the variously modified ileum and that in the present species the proctodeaum is so greatly reduced, one is moved to ask whether the diverticulum may not, itself, be an extremely modified ileum.

The Malpighian tubules lie in an apparently but not really tangled mass, dorsal to the posterior portion of the ventriculus, and end blindly. They are shown in the drawings as being cut off near their origins. It is interesting, in view of their mode of origin by evagination from the intestine, that although they are looped upon themselves and each other in almost every conceivable manner they were never found to be knotted or tangled. Their length is considerable, one which was measured by the writer being over twenty-five millimeters long. They are held together in a mass by connective tissue, but in no case were they found to be inserted into the wall of the alimentary canal nor bound by the peritoneal sheath of the alimentary tube.

THE HISTOLOGICAL STRUCTURE OF THE ALIMENTARY CANAL

THE STOMODAEUM

The *cibarium* (Fig. 3) is entirely chitinous and is, according to Snodgrass (28), "truly a preoral structure. . . . Its concave floor is formed by the adoral surface of the base of the hypopharynx, flanked by the suspensorial sclerites of the latter; its roof, or anterior wall, is the epipharyngeal surface of the clypeus." It consists, in the present species, of a thick walled groove which forms the ventral half of a tube, the dorsal half of which is the thin, elastic operculum. Arising from the dorsal mid-line of the operculum is a row of chitinous tendons on which are inserted the dilator muscle fibers. These muscles originate on the clypeus, lateral to the mid-line, so that in cross section of the head capsule they form a V. No other muscles are present in the cibarium. When the dilator muscles of the cibarium are relaxed the operculum is folded into the groove. When these muscles contract, it is raised, forming a canal, rhomboidal in cross section and with greatly

increased capacity. It is by means of the suction thus produced that the insect ingests its liquid food. The return of the operculum to its normal position is effected by its natural elasticity.

Ventrad of the brain the cibarium merges into the greatly reduced *pharynx* which, in turn, opens into the *oesophagus*. Its walls are continuous with the chitinous intima of the oesophagus. This is surrounded by a columnar epithelium by which, apparently, it is secreted. In the same region a well developed band of circular muscles appears, forming a sphincter which, undoubtedly, aids in preventing the anterior movement of food from the ventriculus during the suctorial process. Also, according to Bugnion (4), it pushes the liquid food along its way. Further posteriad a few scattered longitudinal muscle fibers are found entad of the circular layer. The oesophagus, ventriculus and intestine are enveloped in a thin peritoneal sheath which is frequently difficult to demonstrate. There is, however, no question as to its presence.

The oesophageal intima appears to nearly fill the canal formed by the epithelial layer of cells (*vide*, Fig. 4 and Fig. 5). It is projected a short distance into the lumen of the ventriculus (Fig. 5) and may have, in a passive way, some valvular action. The writer was unable to determine whether the intima is composed of a solid mass of very transparent chitin, of intersecting membranes or of chitinous strands. Perhaps some microchemical tests, such as described by Campbell (8) would be of assistance in answering this question.

Just anterior to the stomodeal valve the order of muscle layers of the oesophagus is reversed, the longitudinal muscles coming to lie outside the circular layer. Obviously, however, this reversal does not mark the point of junction of the stomodaeum and the ventriculus, because in none of the specimens studied histologically was there any change in the nature of the epithelium at this point. Besides, the junction is clearly shown at a point further posteriad.

The oesophagus widens slightly at its posterior end and the cells of the epithelium become elongate, extending, slightly, into the lumen of the ventriculus. This may be clearly seen in Figure 5. The juncture of the stomodaeum and ventriculus is marked by the abrupt change in the cells of the epithelial layer from the elongate type just mentioned to the shorter, more regular, but still columnar type characteristic of the entire mesenteron. Both longitudinal and circular muscles are demonstrable in this region but the latter, in particular, are scarce. Hence any valvular function must be accomplished by the pressure of food material in the ventriculus on the projecting tube of oesophageal intima. If this is not sufficient to prevent regurgitation, the action of the sphincter, previously mentioned, provides an adequate supplement.

THE VENTRICULUS

The ventriculus as a whole conforms to the typical histological pattern. It is lined by a layer of epithelial cells, usually columnar in form and resting on a thin basement membrane which is surrounded, in turn, by circular muscles, longitudinal muscles and a peritoneal sheath. Nowhere is there evidence of a peritrophic membrane. Throughout

the ventriculus the free margin of the epithelial cells bears a striated border except during the active secretory phase. Secreting cells were observed only anterior to the dilated portion of the second stomach. Secretion is of the apocrine type, the fluid to be secreted accumulating in the distal end of the cell which becomes distended and is finally pinched off, leaving the rest of the cell intact. The secretion is subsequently released into the lumen of the ventriculus and the cell, after a period of rest, may again become active. Snodgrass (28) describes this as the typical method of secretion in adult insects. As might be expected, no nidi of regenerative cells were observed.

Yung-Tai (31) and others maintain that secretions are in the form of diffusible liquids and that such processes as described above are the discharge of cytoplasmic disintegration products. The present investigations are not of such nature as to throw any light on this question.

The writer has not seen the term *apocrine* used in entomological literature but it is in common use by histologists in the medical profession (21).

The *first stomach* (Vent 1) is thin walled and the musculature is much reduced. It should be noted that the large diameter of this region is not caused by distension. The epithelial cells appear, rather, to be crowded. It is also interesting to observe that in spite of the fact that both longitudinal and circular muscles are comparatively fewer in this region than in any other part of the alimentary canal, this is the only place where peristalsis was seen to occur during dissection.

Malouf (18) states that in *Nezara viridula*, another pentatomid, this region is lined by a chitinous intima and he, therefore, considers it to be a part of the stomodaeum. No trace of a chitinous intima is present in this part of the alimentary canal of *Murgantia* and there can be no question but that in this species it is definitely a part of the ventriculus.

The *second stomach* (Vent 2) is not remarkable anterior to its dilated portion, it being the least specialized part of the entire alimentary canal. It will be observed (Fig. 9) that the epithelial tissue in the enlarged region has been stretched until the cells have assumed a cuboidal in place of a columnar form. Further evidence of distension is the fact that if the bulb is punctured during dissection the contents are forcibly ejected. The dilatation is never obliterated in such cases nor during hibernation, but this may indicate either that the muscles have lost their tonus or that some progress has been made in the evolution of a permanent structure. No sections were made from hibernating specimens so the histological structure of the bulb in its reduced condition is unknown. Posteriorly the columnar form of epithelial cells is resumed.

Nearly to the posterior end of the second stomach there is a slight elongation of the cells of the epithelium, accompanied by a slight concentration of circular muscle fibers (Fig. 10). This suggests the possibility of a valvular action controlling the passage of food or food residues into the third stomach. The presence of such a valve would aid in explaining the pressure apparent in the bulbous region just anterior. The need, if any, for the retention of food or food residues in the second stomach or for the regulation of their passage into the

third stomach must remain unexplained in a purely morphological study. However, the question is interesting and its solution might throw additional light on the function of the gastric caeca of this and related insects.

The *third stomach* (Vent 3) is distinguished by the four rows of caeca which are formed by evagination (12) from the embryonic ventriculus. Each caecum is disc shaped and consists, apparently, of an extremely thin wall of epithelial cells, which are stretched beyond recognition. The nuclei of the epithelium are shown (Nuc Epl) in muscles are found in the caecal walls. Glasgow (12) reports that the Figure 11. No muscles are found in the caecal walls. Glasgow (12) reports that the caeca are filled with specific bacteria which are transmitted from generation to generation through the embryo. These bacteria are said to prevent the infestation of this region of the ventriculus by other forms. This is considered to be beneficial to the insect and Weber (29) terms the caeca, descriptively, *symbionten krypten*. The sectioned material does not show recognizable bacterial forms, but this is undoubtedly a result of the action of the reagents used in the histological preparation of the tissues.

The alimentary canal proper, in this region, is of small caliber. When it is contracted the epithelial cells are columnar but when it is distended they assume a cuboidal form. Both circular and longitudinal muscles are present and lie close to the epithelium. The wall is, therefore, quite compact. The peritoneal membrane is folded around and between the rows but not between the individual caeca and lies very close to the enclosed structures.

THE PYLORUS AND THE PROCTODAEUM

Immediately posterior to the caecal region is found the pylorus, which marks the junction of the ventriculus with the proctodaeum.

The *pyloric valve* (Fig. 12), like the stomodeal valve, is poorly supplied with muscles. It consists of elongated cells of the ventricular epithelium, extending into the lumen of the anterior intestine, the walls of which are folded at this point. The valvular action must be largely dependent on the pressure of the contents of the proctodaeum on the extended walls of the ventricular epithelium. As in the case of the stomodeal valve the function must be the prevention of regurgitation.

The *anterior intestine* is thick walled, the thickness being due, largely, to the extreme length of the columnar epithelial cells. Longitudinal muscles are scarce and circular muscles are almost entirely lacking. There appears to be a layer of connective tissue immediately outside the epithelial layer of cells.

The *diverticulum* into which the Malpighian tubules empty is similar to the anterior intestine in histological structure and the various tissues are continuous. The epithelial cells of the diverticulum, however, are larger and are of the cuboidal type. Figure 12 shows the histological structures of the anterior intestine, the pouch and a Malpighian tubule.

In structure, the *Malpighian tubules* are very simple, appearing in cross section to consist of three or four large cells with large nuclei. The lumen of the tube is lined by a striated border. No muscle layers are present nor could a peritoneal membrane be distinguished.

Two types of cells are found in the epithelium of the posterior intestine or *rectal sac*. The more common type are large and variously shaped and in general have comparatively large nuclei. The others are narrow and crowded, occurring in groups which are irregularly distributed. Figure 15 shows the structure of both types clearly. The writer found no basis on which an attempt to homologise the groups of smaller cells with the rectal pads of other insects might be justified and no indication of their function was apparent.

No longitudinal muscles were to be found in the wall of the rectal sac but there are numerous circular muscles. It has already been noted that these muscles contract, periodically, emptying the sac of its contents. A layer of connective tissue lies between the circular muscle band and the thin peritoneal membrane.

The beginning of the *anal canal* (Fig. 14) is marked by a well-developed group of circular muscles located at the anterior border of the anal capsule and forming an anal sphincter (Fig. 14, M An Sph). It should also be mentioned that no chitinous intima could be discerned lining the proctodaeum anterior to this point. Posteriorly the canal consists simply of an invagination of the body wall as shown. The epithelium or hypodermis of the canal is continuous with the epithelium of the rectal sac.

THE SALIVARY SYSTEM

In *M. histrionica*, as in many other Hemiptera, the salivary system is both prominent anatomically and important in the nutritive processes of the insect. It, therefore, merits especial discussion.

The two salivary glands are unequally bilobed and lie dorsal to the ventriculus in the thorax, the larger and posterior lobes extending into the abdomen. Each principal gland is provided with a filiform accessory gland lying laterad and emptying by means of a long duct which extends into the head capsule, retroverts into the abdomen, is anteverted, undergoes a series of convolutions and finally opens at the juncture of the two lobes of the principal gland. From this point the salivary duct arises and passes directly into the head to unite with its bilateral opposite and empty, finally, into the chamber of the salivary syringe.

The *syringe*, a remarkable force pump, lies in a horizontal position between the arms of the tentorium, just ventrad of the cibarium. Its powerful retractor muscles are inserted on the flattened chitinous rod which is continuous with the piston and probably have their origins on the lateral arms of the tentorium and the ventral wall of the head capsule.

The following discussion is translated from Bugnion and Popoff (5): "In the Hydrocores, the accessory salivary gland serves the purpose of a reservoir, and lies beside the oesophagus, inside the thorax. The secretion of the accessory gland may, depending on the circumstances, enter the principal gland, which then serves as a reservoir, and mix with the secretion of the latter before flowing outside.

"A study of inferior forms (Aphids) shows that the salivary glands of Hemiptera are primitively tri-lobed, two of which remain contiguous while the third is more detached and is elongated.

". . The ducts, in the Geocores, are also glandular, being secretory as well as conducting organs.

"The salivary glands of the Hemiptera are morphologically labial glands, corresponding to those of the Diptera, Hymenoptera and Orthoptera. They are also homologous with the silk glands of the silkworm, the principal glands corresponding to the gland of Filippi and the accessory gland of the silk gland proper. They arise as diverticula of the stomodaeum, thus being ectodermal in nature. . .

"The saliva of phytophagous Hemiptera is alkaline in nature and probably has two functions, first, to cause the sap to flow and second, to dissolve the cellulose walls of the host plant cells and perhaps begin the digestion of the starch grains. The efferent salivary duct leads to the excretory canal, not to the pharynx. The digestive action of the saliva, begun outside, is probably continued in the stomach, considerable saliva being drawn up with the sap. In predaceous groups the secretion is toxic."

The walls of the principal glands consist of a single layer of cuboidal epithelial cells. No chitin was observed in the gland proper although the ducts of both the principal and accessory glands are provided with a heavy chitinous lining.

The duct of the accessory gland is inserted, the salivary duct originates and an opening between the two lobes of the principal glands occurs in an isthmus of columnar cells as shown in Figure 16a.

Unfortunately, during the making of histological preparations for the present study, none were made of the accessory salivary gland alone. However, in cross sections of a teneral individual, certain tubes appear which conform almost perfectly to Breakey's (7) description of the accessory gland in *Anasa tristis*. The cells are large, have large, deeply staining nuclei and have the general characteristics of glandular cells. Although none were observed in the actual process of secretion, many appeared to be distended.

The epithelium of the principal gland in no case appeared to be of a secretory nature. The gland is, however, usually filled with a homogeneous material which stains very evenly with Fast Green, F. C. F. In view of all the foregoing evidence the opinion is hazarded that in *M. histrionica* the salivary fluid is secreted chiefly by the accessory gland and that the function of the principal gland is largely that of a reservoir.

The salivary syringe (Fig. 17) is of the usual type. It consists of a heavy chitinous cupula, firmly attached to the tentorium, and a chitinous piston, the two being united by an elastic chitinous diaphragm. The contraction of the retractor muscles of the piston enlarges the cavity of the cupula and permits the saliva to flow in through the afferent duct. When the muscles relax, the piston is returned to its former position by the elasticity of the diaphragm, thus forcing the saliva out through the efferent duct. The entrance of the common salivary duct to the cavity of the cupula is provided with a chitinous flap which acts as a valve and prevents the salivary fluid from being forced backward through the afferent duct during ejaculation. No valve is present in the efferent duct but the walls are apparently elastic and are in apposition except when saliva is being ejected from the syringe.

Neither the efferent salivary duct nor the food canal were traced to their extremities in the beak but Weber (29) and Awati (1) state that in most if not all Hemiptera they remain distinct. The latter paper gives an excellent discussion of the structure and function of the salivary apparatus and the mechanism of suction in *Lygus pabulinus*.

BIBLIOGRAPHY

(1) **Awati, P. R.** 1914. The mechanism of suction in the potato capsid bug, *Lygus pabulinus* Linn. Proc. Zool. Soc. London, 1914, pt. 2, pp. 685–733.

(2) **Bordas, L.** 1908. Le caecum rectal de quelques Hemipteres aquatiques. Bull. de la Soc. Zool. de France 33: 27–30.

(3) **Bugajew, I. I.** 1928. Zum Studium des Baues der malpighischen Gefässe bei den Insekten. Zool. Anz. 78: 244–255.

(4) **Bugnion, E.** 1907. L'appareil salivaire des Hemipteres. Paris, Bull. Soc. Ent., 1907, pp. 347–350.

(5) **Bugnion, E. et Popoff, N.** 1908. L'appareil salivaire des Hemipteres. Arch. Anat. Microsc. 10: 227–268.

(6) **Bugnion, E. et Popoff, N.** 1910. L'appareil salivaire des Hemipteres (deuxieme partie). Arch. Anat. Microsc. 11: 435–456.

(7) **Breaky, E. P.** 1936. Histological studies of the digestive system of the squash bug, *Anasa tristis* DeG. (Hemiptera, Coreidae). Ann. Ent. Soc. Amer. 29: 561–573; 4 plates.

(8) **Campbell, F. L.** 1929. The detection and estimation of insect chitin; and the interrelation of chitinization to hardness and pigmentation of the American cockroach, *Periplaneta americana* L. Ann. Ent. Soc. Amer. 22: 401–426.

(9) **Deegener, P.** 1913. Der Darmtraktus und seine Anhange. In: Handb. der Entomologie, hrsg. von C. Schroeder, Jena. pp. 234–315.

(10) **Faure-Fremiet, E.** 1910. Contribution a l'etude des glandes labiales des Hydrocorises. Ann. des Sci. Natur. (Zool.) 9 Ser. 12: 217–241.

(11) **Forbes, S. A.** 1896. Bacteria normal to the digestive organs of Hemiptera. Bull. Ill. State Lab. Nat. History 4: 1–7.

(12) **Glasgow, Hugh.** 1914. The gastric caeca and the caecal bacteria of the Heteroptera. Biol. Bull. 26: 101–170.

(13) **Imms, A. D.** 1924. A General Textbook of Entomology. E. P. Dutton & Co., New York.

(14) **Kennedy, C. H.** 1932. Methods for the study of the internal anatomy of insects. H. L. Hedrick, Columbus, Ohio.

(15) **Kershaw, J. C.** 1911. Notes on the salivary glands and syringe of two species of Hemiptera. Ann. Soc. Ent. Belgique 55: 80–83.

(16) **Knuppel, A.** 1886. Ueber Speicheldrusen von Insecten. Arch. fur. Nat. 52: 269–303.

(17) **List, J. H.** 1886. *Orthezia cataphracta* Shaw, eine Monographie. Z. fur wiss. Zool. 45: 1–86. Summary in Jour. R. Micr. Soc., 1887, pp. 228–229.

(18) **Malouf, N. S. R.** 1933. Studies on the internal anatomy of the "stink-bug," *Nezara viridula* L. Bull. de la Soc. Royale Ent. d'Egypte 17: 96–119.

(19) **Marchal, P.** 1896. Remarques sur la fonction et l'origine des tubes de Malpighi. Bull. Soc. Ent. de France, 1896, pp. 257–258.

(20) **Mayet, V.** 1896. Une nouvelle fonction des tubes de Malpighi. Bull. Soc. Ent. de France, 1896, pp. 122–127.

(21) **Maximov, A. A. and Bloom, W.** 1934. Textbook of Histology, Second edition, Saunders, Philadelphia.

(22) **Metcalf, C. L. and Flint, W. P.** 1928. Destructive and Useful Insects. McGraw-Hill Book Co., New York.

(23) **Muir, Frederick.** 1907. Notes on the stridulating organ and stink glands of *Tessaratoma papillosa*. Trans. Ent. Soc. London, 1907, pp. 256–258.

(24) **Pantel, J. et Licent, E.** 1910. Remarques preliminaires sur le tube digestif et les tubes de Malpighi des Homopteres superieurs. Bull. Soc. Ent., 1910, pp. 36–39.

(25) **Pettit et Krohn.** 1904. Sur la structure de la gland salivaire du Notonecte. Arch. Anat. Microsc. 7: 351–368.

(26) **Saint-Hillaire, K.** 1927. Vergleichend-histologische Untersuchungen der Malpighischen Gefasse bei Insekten. Zool. Anz. 73: 218–229.
(27) **Smith, Kenneth M.** 1926. A comparative study of the feeding methods of certain Hemiptera and the resulting effects upon the plant tissue, with special reference to the potato plant. Ann. Appl. Biol. 13: 109–139.
(28) **Snodgrass, R. E.** 1935. Principles of Insect Morphology. McGraw-Hill Book Co., New York.
(29) **Weber, H.** 1930. Biologie der Hemipteren. J. Springer, Berlin.
(30) **Weber, H.** 1933. Lehrbuch der Entomologie. Gustav Fischer, Jena.
(31) **Yung-Tai, Tschang.** 1929. Recherches sur l'histogenese et l'histophysiologie de l'epithelium de l'intestin moyen chez un lepidoptere (*Galleria mellonella*). Bull. Biol. France et Belgique, Suppl. 12, pp. 1–144.

EXPLANATION OF PLATES

Plate I

Fig. 1. Dorsal aspect of the alimentary system, including the salivary system, *in situ*. Only the proximal portions of the Malpighian tubules are shown.
Fig. 2. Gross anatomy of the alimentary canal. Only the proximal portions of the Malpighian tubules are shown.

Plate II

Fig. 3. Cross-section of the cibarium and its supporting structure.
Fig. 4. Cross-section of the oesophagus.
Fig. 5. Longitudinal section of the oesophageal valve.
Fig. 6. Cross-section of the first stomach.
Fig. 6a. Portion of cross-section of the first stomach, highly magnified.

Plate III

Fig. 7. Longitudinal section of the junction of the first and second stomachs.
Fig. 8. Cross-section of the anterior portion of the second stomach.
Fig. 9. Highly magnified portion of cross-section of the wall of the bulbous portion of the second stomach.
Fig. 10. Longitudinal section of posterior portion of the second stomach, showing the valvular structure occurring just anterior to the caecal region of the ventriculus.

Plate IV

Fig. 11. Cross-section of the third stomach, including the gastric caeca.
Fig. 12. Longitudinal section through the pyloric valve.
Fig. 13. Cross-section of the anterior intestine and ileum.
Fig. 14. Longitudinal section through the anal capsule. The external wall on the right hand side of the drawing is in an abnormal position.

Plate V

Fig. 15. Cross-section through a portion of the wall of the rectal sac.
Fig. 16. Longitudinal section through the principal salivary gland.
Fig. 16a. Longitudinal section through isthmus of principal salivary gland, taken near region of figure 16. Semi-diagrammatic.
Fig. 17. Longitudinal section through the salivary syringe.
Fig. 18. Cross-section through the salivary duct. Note the tongued and grooved nature of the cell walls.

KEY TO THE ABBREVIATIONS USED WITH THE FIGURES

Ac Gl—Accessory salivary gland.
Af D—Afferent duct of the salivary syringe.
Ant Int—Anterior intestine.
Atyp Cell—Atypical or unusual type of cell in rectal epithelium.
Bact?—Bacterial remains (?) in gastric caecum.
Chit Epi—Chitogenous epithelium.
C M—Circular muscle.
Con T—Connective tissue.
Cup—Cupula of the salivary syringe.
D Ac Gl—Duct of the accessory salivary gland.
Ef D—Efferent duct of the salivary syringe.
Epi—Epithelium.
Epi of Proct—Epithelium of the proctodaeum.
Epi of Stom—Epithelium of the stomodaeum.
Epi of Vent—Epithelium of the ventriculus.
Epi Sal Gl—Epithelium of the salivary gland.
Int—Chitinous intima.
Isthmus — Isthmus connecting the anterior and posterior lobes of the principal salivary gland.
L M—Longitudinal muscle.
Lu—Lumen.
Lu An Cnl—Lumen of the anal canal.
Lu Ant Int—Lumen of the anterior intestine.
Lu Ant Lobe—Lumen of the anterior lobe of the principal salivary gland.
Lu Ileum?—Lumen of the pouch into which the Malpighian tubules empty.
Lu Post Lobe—Lumen of the posterior lobe of the principal salivary gland.
Lu Vent 1—Lumen of the first stomach.
Lu Vent 2—Lumen of the second stomach.
Lu Vent 3—Lumen of the third stomach.
M An Sph—Muscles of the anal sphincter.
M T—Malpighian tubule.
Nuc—Nucleus.
Nuc Epi—Nucleus of epithelial cell in the wall of a gastric caecum.
Oper—Operculum of the cibarium.
Piston—Piston of the salivary syringe.
P M—Peritoneal membrane.
Rect Epi—Usual type of cell in rectal epithelium.
Rect Sac—Rectal sac or posterior intestine.
Sal D—Salivary duct.
Sal Gl—Principal salivary gland.
S B—Striated border.
Sec—Globule of secretion.
Tend—Tendon on which the dilator muscles of the cibarium are inserted.
Tend Syr—Tendon of the salivary syringe; pump handle.
Tr—Tracheole.
Valve?—Valve near the posterior end of the second stomach.
Vent Wall—Ventral wall of the cibarium.

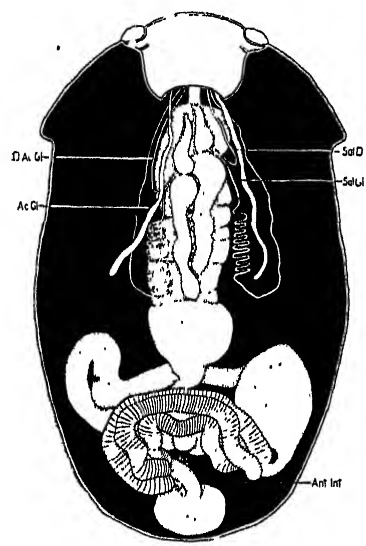


Fig 1

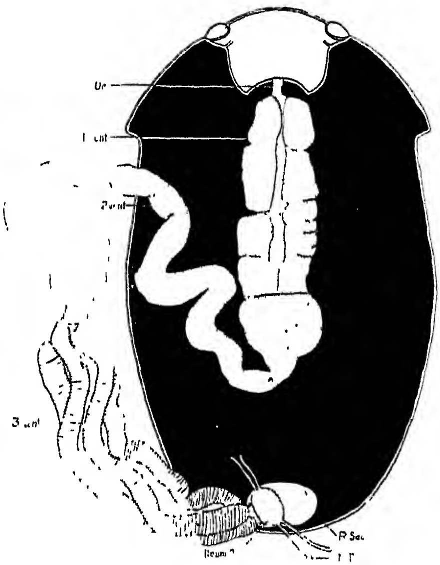


Fig 2

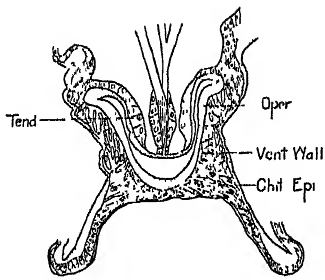


Fig 3

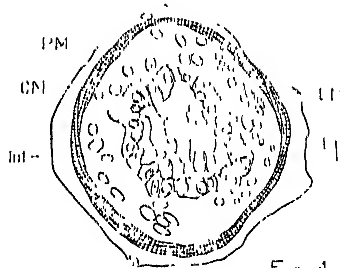


Fig. 4

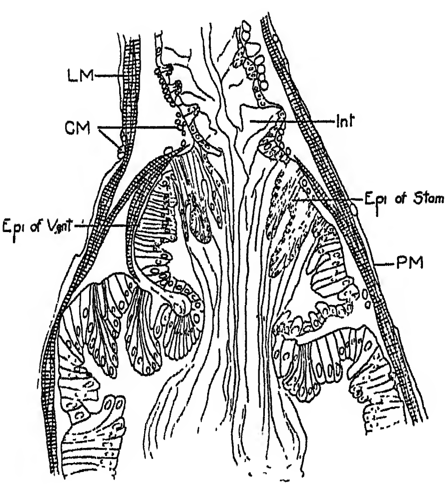


Fig 5

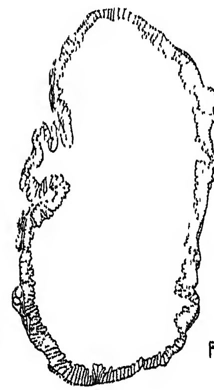


Fig. 6

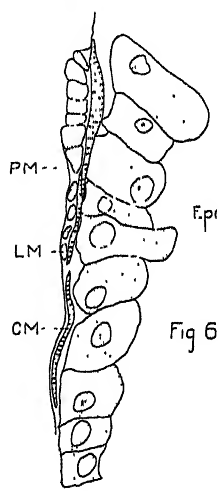


Fig 6a

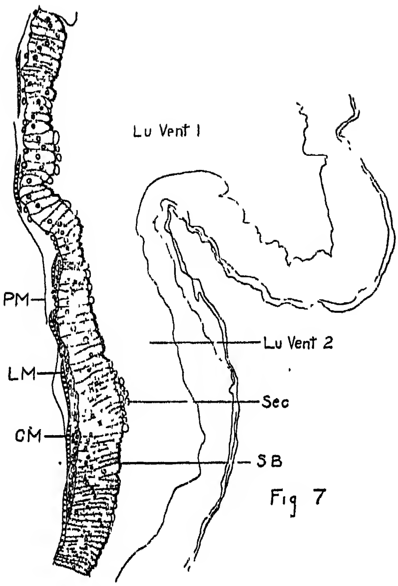


Fig 7

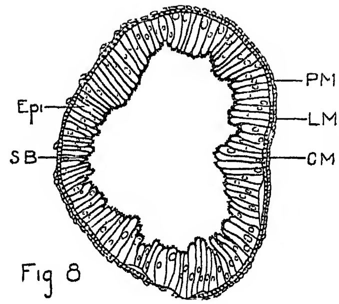


Fig 8

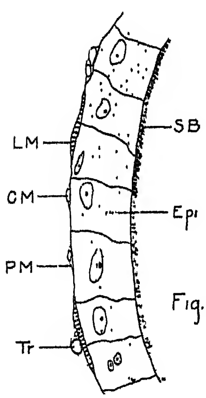


Fig. 9

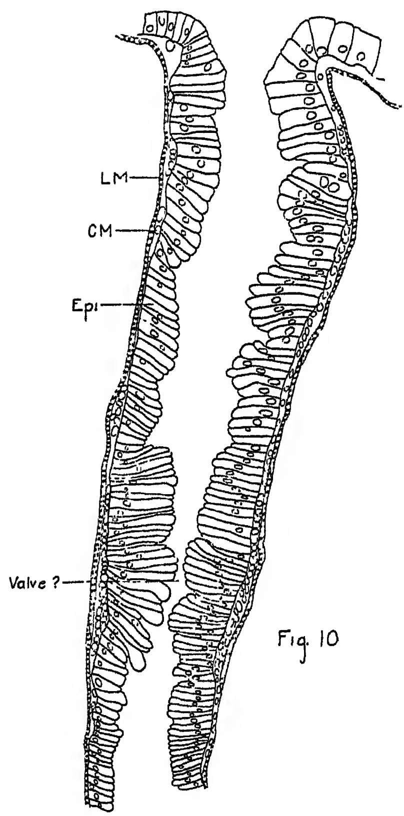


Fig. 10

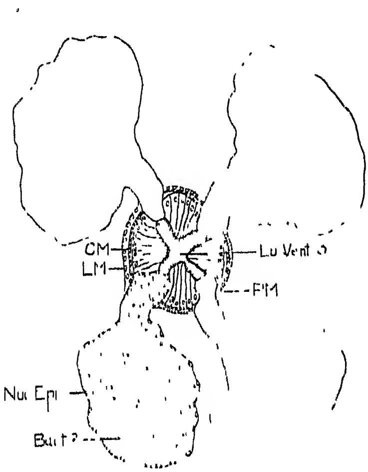


Fig. 11

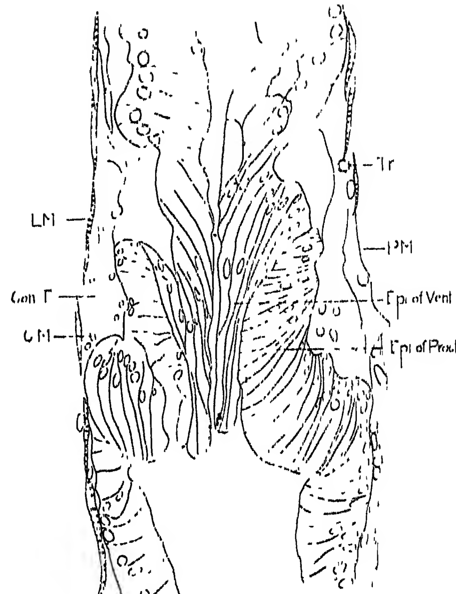


Fig. 12

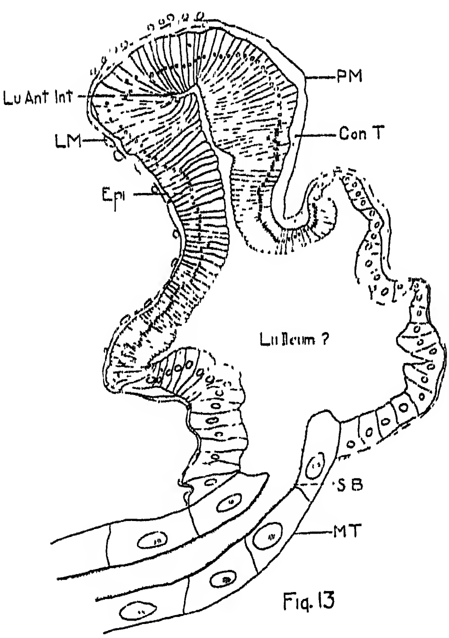


Fig. 13

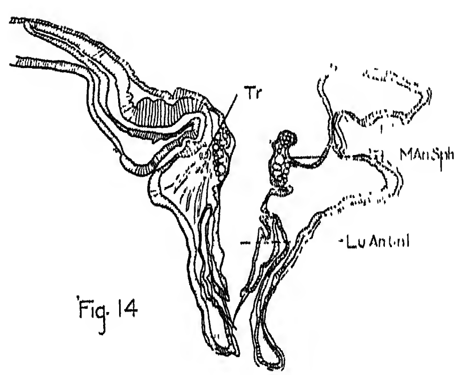


Fig. 14

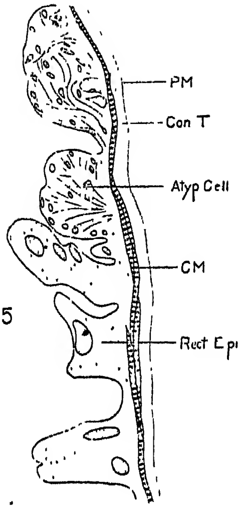


Fig. 15

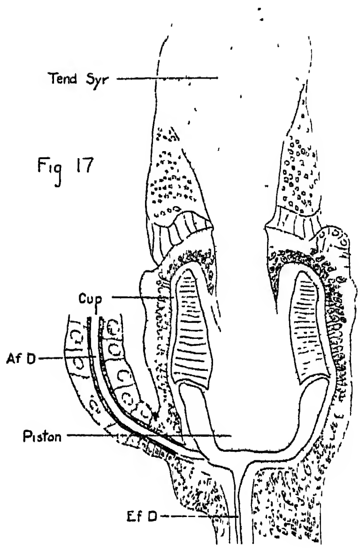


Fig 17

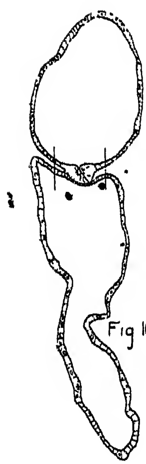


Fig 16

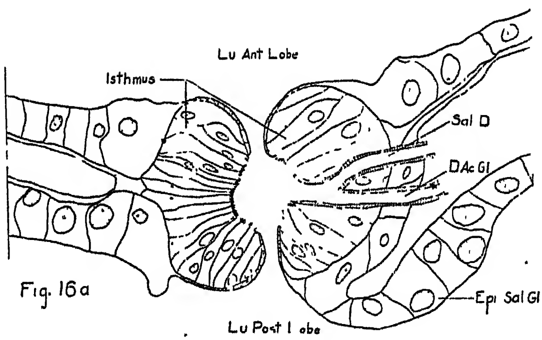


Fig. 16a

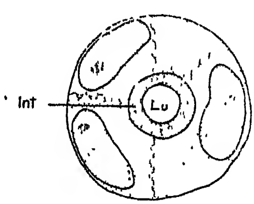


Fig 18

BOOK REVIEWS

The Grass of Many Waters

This book, to the layman and the general student, is the answer to the frequent question, "What are the Algae, and why should I be interested in them?" Due to the author's wide experience in the teaching profession where such questions are of common occurrence, and because of his subtle humor, he has been able to place before the public an interesting and understandable book. Although not written for those "who know all about the algae," such a specialist will find it to be a sound scientific treatment presented in such a manner as to be enjoyable reading.

Early in the book there is a discussion of the organisms which constitute the Algae. Interwoven with this is a comparison of the physiological processes of these organisms with those of the "higher" plants and animals. The greater part of the book is devoted to algal habitats and the economic importance of these plants to the associated organisms, as well as to man. Methods for collecting, preserving and studying the Algae are included, but as it is not taxonomic in nature, keys have been omitted. Excellent figures, photographs and colored plates add materially to the text for those who are unfamiliar with the group.

The book is a remarkably successful attempt to stimulate interest in, as well as to popularize a group of plants formerly considered to belong only to the specialist.

—*C. E. Taft.*

Algae, the Grass of Many Waters, by Lewis Hanford Tiffany. xii+171 pp. Springfield, Illinois, Charles C. Thomas, 1938. $3.50.

A Philosophy of Science

As a result of examining various historical and contemporary views of the interrelation of science and philosophy, the author concludes that instead of formulating the problem in terms of philosophy vs. science, it must be formulated in terms of a philosophy *of* science. This he proceeds to do, by means of problems in the logic of science, problems in the analysis of the concepts of science, and a series of speculative problems. The views of past and present writers on these various topics are constantly examined and interpreted with the author's own critical comments. A chapter on human freedom throws new light on this question, although no claim is made for a complete answer. The book closes with a chapter on the nature of reality, leaving in the mind of the reader, as all philosophical discussions must do, certain doubts and misgivings, but withal a sense of being, temporarily at least, swept free of cobwebs.—*L. H. S.*

An Introduction to the Philosophy of Science, by A. Cornelius Benjamin. xvi + 469 pp. New York, the Macmillan Co., 1937. $3.50.

Flying

American Wings describes in a popular style the development of modern aviation in America. It is of particular interest because it clearly brings out the many applications which are being made of aviation and the way in which planes must be designed to fit different purposes. Naturally a great deal of attention is paid to military aviation, but chapters also describe the work of the airlines, the service which the Coast Guard can render in emergencies to ships at sea, the growing use of planes for private use, and such special uses as mapping and advertising. Of interest is the description of the auxiliary facilities which are necessary under modern conditions such as the radio beacon, the illumination of airways and fields and ground operations. The book is written in a vein which will appeal particularly to the boy of high school age. In view of this appeal the book is to be commended because it gives a rather frank discussion of aviation as a career although it places its emphasis on piloting and dismisses engineering and other services with a paragraph. The book closes with a brief history of the past and a look into the future. It is profusely illustrated, pictures of military aircraft predominating.

—*W. L. Everitt.*

American Wings, by Captain Burr Leyson. New York, E. P. Dutton and Company, 1938. $2.00.

Twenty-five Years Later

For twenty-five years Walter's "Genetics" has retained a deserved popularity. The fourth edition, stream-lined and modernized, is now off the press, and will undoubtedly prove a worthy successor to the earlier editions. The author has an intimate way of "talking" to his readers in intriguing, sometimes humerous, always piquant style. A host of clever diagrams and illustrations add to the readability. The book is pitched at an elementary level, and can not but appeal to the beginning student. The subject is developed historically, using in their turn the observational, the experimental, the statistical, the cytological and the developmental avenues of approach. The book closes with two realistically presented chapters on human heredity and eugenics. A lengthy appendix contains 84 practice problems, some statistical constants and their use, the tracing of family histories, suggested topics for eugenic theses and numerous other facts and suggestions of use to the teacher.

—*L. H. S.*

Genetics, by H. E. Walter. Fourth edition. xvii+412 pp. New York, The Macmillan Co., 1938. $3.00.

Teaching Biological Sciences

Professors D. F. Miller (Zoologist) and G. W. Blaydes (Botanist) of the Ohio State University, have prepared a book on methods and materials for teaching elementary biological sciences which gives every promise of becoming a valuable guide and reference book for all biological teachers in training and in service. Part I of the book is designed primarily as a text for classes in special methods. The ten chapters in Part I cover those questions most frequently asked by student teachers. Some extremely interesting and important information and points of view are presented under the following headings: the biological basis of education, objectives of teaching, types of courses, methods of presentation, making a teaching plan, an evaluating program, lack of materials and equipment, visual education, how to choose a text and trends in the curriculum. Part II contains information primarily for the use of the teacher already in service. Chapter 12 is "chuck full" of suggestions on how to collect, preserve and culture common fauna and flora near any school. The chapters on laboratory aids and substitutes, preparation for the microscope, digestion, nutrition and growth, diffusion, circulation, respiration, water relations to plants, the response of organisms, reproduction and heredity, contain a great deal of information and suggestions on how much subject matter can be presented and detailed information on the preparation of demonstrations and experiments for lecture or laboratory classes.

The authors emphasize the importance of getting the student's mind away from the printed pages of a text book. So far as possible all facts and principles should be illustrated by visual demonstrations. Many fine examples are suggested in the various chapters of Part II. Briefly stated, the emphasis is "Study nature, not books." For all teachers of biology, especially for progressive individuals, this volume will be of decided value.—*Alvah Peterson.*

Methods and Materials for Teaching Biological Sciences, by D. F. Miller and Glenn W. Blaydes. xii+435 pp. New York, the McGraw-Hill Book Co., Inc., 1938. $3 50.

Insects of Citrus and Subtropical Fruits

For anyone seeking answers to questions on insects affecting citrus and other subtropical fruits (avocado, vinefera grapes, Persian walnut, almond, pecan, fig, olive, date, oriental persimmon, pomegranate, sweet cherry, etc.) undoubtedly the most satisfactory source of information will be Prof. H. J. Quayle's new book, entitled "Insects of Citrus and Subtropical Fruits." This book is the result of a life time study by Prof. Quayle of all the important insects throughout the world that attack commercial subtropical fruits. The author also has assembled the most important world literature in this field. The numerous drawings, diagrams, photographs, tables, keys to insects, and citations to literature make this volume an exceedingly valuable reference for any library housing biological books. An outstanding feature is the extensive and thorough-going presentation of the information about the natural enemies (diseases, predators and parasites) of the respective insect and other arthropod pests. This important phase of insect control is usually

omitted or merely mentioned in most volumes discussing insect pests of economic plants. The chapters on insecticide control, especially the chapter dealing with field fumigation where canvas is placed over trees or ground plants, bring together the latest information in these fields. All told, the author has prepared an excellent book which will be of decided value to entomologists, subtropical fruit growers and others.—*Alvah Peterson.*

Insects of Citrus and other Subtropical Fruits, by Henry J. Quayle. ix+583 pp. Ithaca, The Comstock Publ. Co., 1938. $5.00.

— — —

"Reptiles of Ohio" Brought up to Date

Roger Conant's Reptiles of Ohio has at last appeared! Naturalists of the state have for some time eagerly awaited this publication, so badly needed to bring our records up to date. This is the third list of Ohio reptiles to be published, dating from Smith's report in the Ohio Geological Survey of 1882, followed by Max Morse's paper of 1904, published in the Proceedings of the Ohio State Academy of Science. Conant's work is undoubtedly the most thorough-going study of Ohio reptiles yet made. The list includes 4 lizards, 10 turtles, and 25 snakes, based on records and specimens in collections throughout the state, supplemented by collections by the author in 80, and visits to 87, of the state's 88 counties. Each species is fully described along with its habitat and habits. A map of Ohio shows locality records, and a small U. S. map shows the general range of the species. A detailed list of all known specific records is given, with places and dates. This 200-page paper also includes a key to the species, a discussion of the physiography and geography of the state, a glossary, an extensive bibliography, notes on first aid in treatment of snake bite and suggestions for collecting and preserving specimens. The numerous excellent photographs are an attractive feature. It certainly deserves a place on the shelf of every naturalist's library in the state.—*J. W. Price.*

The Reptiles of Ohio, by Roger Conant. Cloth bound, reprinted from The American Midland Naturalist, 20: 1–200, July, 1938. Notre Dame, Indiana, The University Press.

College Physics

This is a text-book in college physics suitable for use in courses for technical students and for use by college sophomores who have had some introduction to the subject. The use of calculus is entirely excluded and only algebra and trigonometry are required. The material is treated in much the conventional order and each section is clearly illustrated. The expository material is written in concise and readable language and should appeal to the reader for whom it is intended. At the end of each chapter is found a list of problems with answers which are useful in clarifying for the student the principles which he has been reading about. As is the case with a great many other books of its kind, far more material is included than can efficiently be covered in two semesters or three quarters, but considered as a whole Dr. Perkins' book should prove itself useful in sophomore college courses in physics for technical and non-technical students.—*H. H. Nielsen.*

College Physics, by Henry A. Perkins. ix+820 pp. New York, Prentice-Hall, 1938. $3.75.

Abbreviated Physics

"The widespread antipathy on the part of most students to the application of mathematical methods" is the authors' reason for preparing "a brief, non-mathematical survey of the whole field of physics." Equations are relegated to an appendix, and replaced in the body of the text by equivalent verbal statements: "the distance covered by a body in uniformly accelerated motion, starting from rest, is equal to the product of half the acceleration by the square of the elapsed time." A four-page appendix tells of the influence of heat engines, electric power, electrical communications, and sound-motion pictures on civilization. Nine pages are devoted to topics of special interest to pre-medical students. As a text-book for short courses in physics, with demonstrations and discussions to make up for extreme brevity of the text, this book may find a useful place.—*Harold Knauss.*

Elementary Survey of Physics, by Arthur E. Haas and Ira M. Freeman. 203+xii pages. New York, E. P. Dutton and Company, 1938. $1.90.

INDEX TO VOLUME XXXVIII

Date of Issue	Date of Issue	Date of Issue
1-12-55	17.12.64	
17.2.58	10.8.65	
17.6.58	[illegible] 9.65	
30.5.58	[illegible]	
30.1.59	[illegible]	
[illegible] 59	[illegible]	
6.8.60		
8-6-61		
5/9/61		
13.11.61		
10.10.62		
20/12/63		
[illegible]		
20.x.64		

GIPNLK—H-40 I.A.R.I.—29-4- 5—15,000